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Contents for January 9, 1930

VOLUME 104, NUMBER 2

Copyright, 1930, by McGraw-Hill Publishing Company, Inc.

Grand Canyon Suspension Bridge 56
By FRANK A. KITTREDGE

Board Reports on Colorado Aqueduct 59

Damages for Boeuf Floodway 60

Rainfall Studies at Seattle 61

Durability of Portland Cement 62
By THADDEUS MERRIMAN

Sewage Farm Displaces Filters at Vineland 65
By GEORGE A. MITCHELL

Circular Cell Cofferdam at Deadman Island 66
By WILLIAM H. FOWLER

One-Way Concrete Slab Floors 68
By GEORGE RUNCIMAN and H. L. WORTHINGTON

Responsibility for Deaths From Water 70

Light Floors for Bridges 71
By LEON S. MOISSEIFF

Ventilation in Tunnel Driving 74

Air-Rail Station at Columbus, Ohio 75

Airport Competition Results 77

Editorial 53 Letters 81 News 82 Equipment 87

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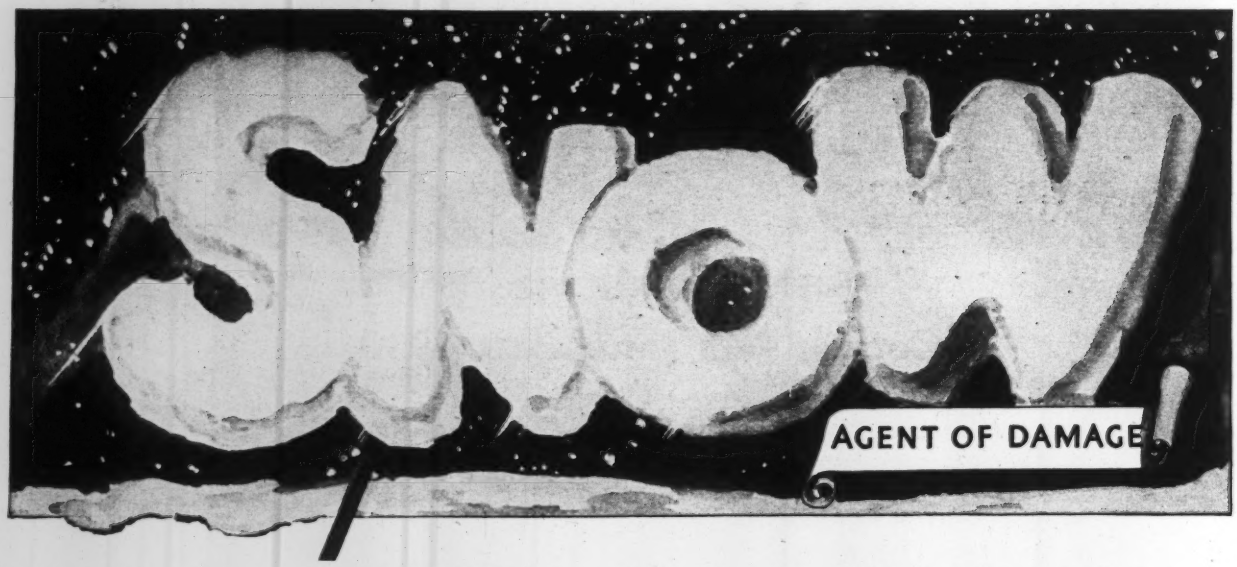

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, JANUARY 9, 1930 Number 2

Colorado Aqueduct Planning

ONE prime result achieved by the excellent preliminary report of the Colorado River aqueduct board, just made public, is to lay at rest the ghosts and shades of gravity-flow schemes that have haunted the public discussion of the project for some time past. The work to be done is too big and too important to be left hazily involved with fanciful possibilities; the need for the aqueduct is urgent, the time to build it is none too ample, and definite planning and construction must start before long. A wide range of selection still remains among the four general routes and numerous variants outlined by the board. In stripping the enterprise of some major complications the board has accomplished a constructive piece of work directed toward progress.

Lake Diversion Reduced

THE first official reduction of the Chicago sewage-flushing diversion from the Great Lakes is made by the War Department's renewal permit of Jan. 1, which as reported from Washington authorizes only 7,250 cu.ft. per second, in place of the 8,500 cu.ft. of the former permit. The change implies that the government means to go forward consistently in applying the Supreme Court decision of a year ago, even though that decision will not be translated into specific terms until the court acts on the Hughes recommendations. To Chicago the present reduction is of great importance because of the stress it lays on the need for reform and reconstruction to overcome the formidable handicap of disorganized civic conditions, outlined in this column only a few weeks ago. Meanwhile, as sewage disposal has already progressed to a stage conforming with the reduced diversion, the new permit will work no hardship.

Less Dead Weight

FLOOR weight takes on an ever larger aspect in both building and bridge construction. More work has been done on the problem in application to buildings, but bridge floors, though they present more difficulty, are at present in the foreground because of the great size of bridge projects. Furthermore, floors of permanent type are now considered necessary in many bridges where former practice would have been content with something less enduring. For these reasons the experimental study of a light bridge floor which is reported this week merits close attention. It brings out quite tangibly the large gain to be realized through continuity, besides showing that in point of strength alone it is possible to make a large reduction in bridge weights—for in a large bridge any saving in floor weight leads to a multiplied total saving. At the same time the practical factors of bridge-floor service have to be kept in mind; the testing machine does not reflect all demands which long-time service imposes on a floor. In the case of a recently built bridge, for example, the engineers in charge chose a heavy reinforced-concrete slab in preference to a lighter floor somewhat similar to the one whose test is reported, because they felt less certain about the practical service performance of the latter than about that of the former. Despite such doubts the light-floor field will remain active and interesting, and is likely to show useful development in the next few years.

Preparing Efficiency

WITH conditions settling down to normal after the holiday season, signs multiply that a heavy construction year is ahead. It may not set new records, it may not be big enough to satisfy everyone, but it will keep every efficient worker busy. Last week brought further evidence to this effect in the shape of figures for public and industrial construction that confirm prior evidence as to large volume of work that will need to be done. In the meantime there is a month or two of available time before the actual proof of fact is at hand in the form of calls for bids. This period has a peculiar value under existing circumstances: It is a time for putting plant in shape, overhauling everything, and making ready for most efficient production. One value of such activity is that it will do something toward bridging the winter sag, but its importance to the individual producer is much more direct—it is the means by which he can make certain of being able to produce at low cost in competition with any and all, and at maximum rate of speed if necessary. By profitable employment of his experienced men in this manner, he is assured an experienced crew to start the first job of the season. If prepared in this way, he can look to the year's developments securely. There is reason for expecting that business will be done on closer terms than in 1929, and that the earliest and best work will go to the efficient producer capable of figuring on low margins. This will be the man who has prepared for the active season by checking over his equipment and facilities, by renewing and repairing, and by making ready for work, and who has his old experienced men available at first demand. Manufacturing industries recognize very fully the advantage of timely preparation for the season of heavy demand. The construction industry, which despite the growth of winter construction still remains largely seasonal, should take account of it as thoroughly.

Rainfall Records

THAT even half a century is too short a period for rainfall predictions is illustrated by the 50-year Seattle graph shown elsewhere in this issue. Strikingly evident is the fact that rainfall was abnormally high at the beginning and abnormally low at the close of the half-century ended with 1928. Even when five-year progressive averages are considered, the beginning and end of the half-century were abnormal. It may be assumed, although with no certainty, that the half-century began with rainfall at the peak of a cyclic curve and ended with

the valley reached, but if so even application of the law of probability will not assure water and power users in the Seattle region that the curve has yet reached its lowest point, or whenever reached it will mount to its abnormally high level of a half-century ago. Records elsewhere are of little use in forecasting here, because long-time records are few in number and so far between geographically that differing climatic conditions render comparisons invalid. Broad generalizations may be drawn, but they are of little value for short periods, due to the erratic character of climatic variations from year to year. That these reflections are not a mere matter of curious speculation is shown by the fact that only a few weeks ago Seattle had recourse to emergency aid from a vessel of the U. S. Navy to help out shortage of electric current supplying the city with light and power. If rainfall variations followed known laws, this could have been guarded against—a fact still important, even though more foresight and more co-operation in providing power reserves would have saved the city from much, at least, of its recent embarrassment. We need longer rainfall records and more stations. Time will supply the first lack; as to the second, engineers must awaken the public to the need for more stations and stimulate legislatures to see that they are provided.

Bridging the Grand Canyon

TO THOSE of the profession fortunate enough to have numbered among their experiences the thrills and difficulties of mountain construction, this week's cover picture will at once make an appeal. Unusually simple in detail—a winding trail in the Grand Canyon down which Indian laborers in single file shuffle under the weight of a 1½-in. suspension bridge rope 550 ft. long—the picture is remarkable in that it immediately causes a mental visualization of many other characteristics of the project. A bridge site inaccessible to all save pedestrians and light pack animals; a deep canyon, sheer rock walls, a roaring mountain stream many feet below, and vertical and horizontal air currents of high velocity; stiffening truss and floor members fabricated in short, light-weight shipping pieces; cables and hangers cut to exact length in the shop to eliminate complicated and heavy erection equipment; a narrow structure requiring wind cables for stability; members designed for interchangeability in case one of them should slip over the canyon's rim or be dropped into the river while being handled; natural rock anchorages; dynamited tunnel or open-cut approaches; all of these elements are immediately reflected by the transportation scene shown on the cover. And these, indeed, are the factors about which Frank A. Kittredge, chief engineer of the National Park Service, weaves his unusually interesting story of the Kaibab Trail suspension bridge across the Colorado River in Grand Canyon National Park. Such pictures and such projects add to the civil engineer's legacy.

Pretentious but Possible

AN EXAMINATION of the designs awarded prizes in the airport competition described elsewhere in this issue impresses one immediately with their pretentiousness. Such suggestions as subterranean stations, loading platforms to accommodate five huge transport planes at once, fields with sixteen intersecting runways and depressed lights marking runway center lines seem to be optimistic dreams of air-transport enthusiasts. Perhaps they are. A certain amount of incredulity is altogether natural when these proposed designs are compared with airports as we now know them. Yet one cannot but call to mind another comparison—that between the pasture landing field of three years ago and such ports as the Pan-American Airways Terminal at Miami, the Grand Central Air Terminal at Glendale, and the air-rail terminal at Columbus, the latter, by coincidence, described in this issue. The contrast is about as great in either comparison. Moreover, considerable significance must be accorded the prize airport designs because of the make-up of the jury of awards. It included not only architects and engineers, whose choice of designs to be awarded prizes presumably was based on appearance and technical merit, but air-transport officials who at least think they know what ground facilities they want and can use effectively. None of the prize designs is proposed as an ideal. Rather, various elements of each should be analyzed as to practicability in any airport design of the future. Some one of these elements may encompass important possibilities. The designs are presented in such detail in this issue largely with that idea in view. However, there also lurks the hope that the organizations responsible for the present tendency to diversify terminal facilities in a city—Los Angeles, for instance, has five different fields, and New York City boasts at least as many—may see in these pretentious designs something quite possible and practical were they to pool in a single enterprise the thousands of dollars they now have invested in duplicate facilities. The fact cannot be ignored that regardless of pretentiousness and improbability for the present the prize airport designs nevertheless are quite possible and potentially practical.

Railroad Consolidations

RAILROAD consolidation work in this country now enters a new stage. After nearly nine years of intermittent consideration of the best way in which to group the railroads into a limited number of systems and after several requests to Congress for release from the requirement of producing such a grouping the Interstate Commerce Commission has made public a plan for grouping the railroads of the country into 21 systems. The plan is neither binding nor final.

The Transportation Act of 1920 required that such a plan be promulgated before the final merging of any one railroad company into another could be approved by the commission, in order that such merger would be a step toward the ultimate aim of the act—creating a limited number of competitive railway systems of comparable size and strength. The commission may hereafter modify the plan in the public interest. The railroads may refuse to be bound by it if it does not suit them. What significance, then, lies in this most recent development?

Its significance will depend upon the developments of the next few months. Legislation now being considered by congressional committees may so alter the interstate commerce act as to require entire reconsideration of the subject by the commission. The present plan would then become of no importance. But on the other hand, if one of the major railroad companies comes to the commission before the act is amended, and says that it is ready to undertake the setting up of the new system of which it is to be the nucleus under the present plan, then the commission must give its approval and aid in effecting the required mergers. The possibility of such action seems remote, but if once put under way it might convert what now appears to be just another paper plan into

something to be reckoned with in any future consolidation work. Aside from these two points the only significance of the present plan lies in the fact that in publishing it the commission has carried out the mandate of Congress as written into the Transportation Act. Its action has cleared the way for future developments.

Consideration of the many difficulties involved in putting any railroad consolidation plan into effect raises the question, Why should the railroads of the country be consolidated into a relatively small number of large systems? Are the advantages to be gained real or imaginary? And if real, are they worth the almost endless litigation involved in bringing them about?

At the close of the World War the railroads of the country were in desperate straits and Congress saw ahead the possibility of having to authorize greatly increased railroad rates if the rail transportation system of the country was to be put in shape to handle the growing needs of the country. It saw also that what would be about a living rate for the weak railroad would be more than enough for the strong one. The outcome was the writing into the Transportation Act of two sections tending to stabilize the railroads without unduly enriching any one. The first was the provision for consolidation, which proposed grouping all the railroads into a number of systems of approximately equal size and financial strength; the other was the so-called recapture provision, which required that the railroads pay back to the government one-half of their income in excess of a stipulated amount.

But since the days when the Transportation Act was written the financial position of practically all the railroads of the country has improved greatly. Their equipment has been modernized, their roadbed and structures have been put into good condition, and the efficiency of their men and machines has increased to a point where most railroads are operating on a basis which brings in a reasonable return on the capital invested in them. Doubtless some further improvement could be made by merging some into other systems, but not on the basis simply of producing systems of equal financial strength as required by the transportation act. Economies in overhead and simplification of rates by consolidation are still possible in some circumstances, but the amount appears to have been greatly exaggerated.

To offset these minor advantages the consolidation provisions of the act have many major disadvantages. Strong railroads that now have earnings which make it possible for their managements to keep them in first-class operating condition must be saddled with weak roads bought at figures which are bound to be in excess of their actual value. Also, roads whose earnings have been dissipated by unscrupulous owners must be merged with roads made strong by wise management—to the advantage of the former, the disadvantage of the latter, and no gain to the public. These are disadvantages inherent in the act as now written and quite aside from those involved in the Interstate Commerce Commission's present plan.

The consolidation provisions of the Interstate Commerce Act should be abandoned. They were written into the law as part of what then appeared to be the best possible outside means of putting a lot of sick railroads into shape to meet the country's transportation requirements. They are no longer needed. The railroads are back on their feet. Any attempt to force a consolidation plan upon them now simply because it is on the statute books would be to involve them and the Interstate Commerce Commission in an endless litigation which would more than offset any possible advantages to be gained therefrom. What is needed now is not an amendment to the act to try to fit its provisions to present-day conditions but entire elimination of the consolidation provisions. The problems of today, if they are to be solved, should have the benefit of a clean slate.

Publications and Meetings

THE first issue of the *Journal* of the American Concrete Institute, which appeared recently, marks the discontinuance of the annual *Proceedings* of that society, after the issue of twenty-five volumes. The inauguration of the *Journal* also is accompanied by a radical reshaping of committees and of Institute procedure. Thus does another technical society, faced with the complexity of growing membership and widening fields—perhaps also fearful of becoming old fashioned—respond to the urge for change by revamping its organization and publishing plans.

In major aspect the development is not different from that which has taken place in other societies where journals and diverse publishing innovations have been resorted to as revivifying antidotes for society sterility. The major object and principal theoretical advantage in all cases has been the same—namely, to develop and foster a closer and more current contact with society activities on the part of the far-flung membership. How far this advantage has been realized is as yet uncertain, since in no case has it been proved by results. It may well be that the shortcomings of our technical societies are more deeply rooted. Merely to convert a technical society into a publishing organization and its members into a reading circle will hardly prove effective in counteracting a tendency to drift, if the methods of management have allowed such a tendency to spring up. If journals, news letters and reorganizations are necessary, we should have them, by all means! But let it not be forgotten that they are solely the means to an end; purpose and spirit are the thing itself.

Another society question of considerable moment relates to the practice of combining technical sessions and exhibitions of equipment and materials. In recent years there has been a tendency for the exhibits to surpass the technical sessions in the amount of interest aroused. The problem in its most advanced form confronts the American Road Builders Association, whose convention and road show come next week. Last year the show completely overshadowed the convention, and this despite the fact that many papers of value were presented. The all too apparent reason is that a convention session usually is a stodgy proceeding in contrast with the colorful carnival atmosphere that pervades the exhibits. A ban on the reading of statistical tables and the substitution of lantern slides wherever possible are needed reforms. Where papers are later to be printed in full, an address based on a synopsis of the paper would be a welcome innovation. Such simplification obviously would be advantageous to listener and speaker alike.

Needless to say, these comments are directed to current trends in society fashions and not exclusively to the organizations mentioned. The new *Journal* of the A.C.I. has our best wishes. It only remains to be pointed out that the chairmen and speakers at the road convention have an opportunity to set an example for other societies, if they will but grasp it.

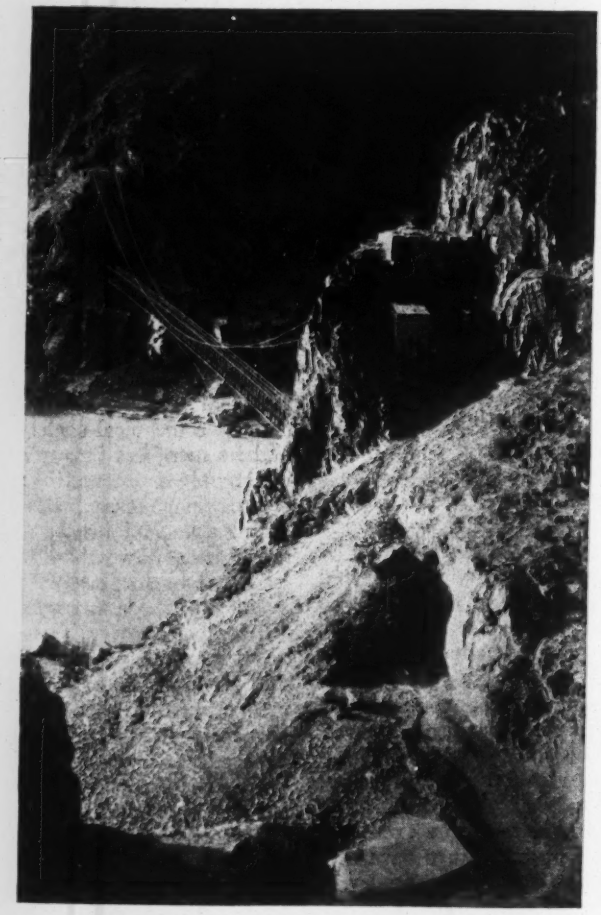
Transportation Problems Govern Suspension Bridge Design

Stiffening Truss Members Limited to 10 Ft. and 200 Lb.—Main Cables Carried Into Grand Canyon by Indians

By Frank A. Kittredge
Chief Engineer, National Park Service

TRANSPORTATION difficulties of unusual severity, requiring the moving of 122 tons of material down 7½ miles of steep, zigzag pack trail, dictated the design and method of construction used for the new Kaibab Trail suspension bridge across the Colorado River in Grand Canyon National Park. The new bridge replaces an old structure where the trail crosses the river just above the mouth of Bright Angel Creek; at this point the canyon is more than a mile deep and about 8 miles wide at the top. The new bridge is 500 ft. long between supports with a 440-ft. stiffening truss designed with members less than 10 ft. long and weighing less than 200 lb. necessitated by the pack-trail transportation. Erection was aided by use of the old bridge, but it also tended to complicate the work because of the care required to construct the new cable anchorages without disturbing those in use.

The new bridge was necessitated because of the limited capacity of the old bridge and its tendency to sway dangerously in a wind of even moderate velocity. The original structure was designed for a load of only one mule and rider at a time and it required a party of ten approximately one hour to cross the bridge even when there was no delay caused by its swaying in the wind. The canyon acts as a funnel for air currents at this point and the wind frequently moves with such high velocity that the old bridge often was impassable and instances are on record of its being lifted and completely inverted. To facilitate construction and to permit keeping the trail open it was decided to build the new bridge directly above the old one. Certain hours of the day were set aside for the passage of tourists across the old structure.



GENERAL VIEW FROM SOUTH SIDE
Note the tunnel approach and the concrete for cable anchorages.

Design—The new bridge is designed according to standard practice except that it was necessary in several instances to modify details to suit the type of transportation available. The clear span is 500 ft. between cable supports and a continuous stiffening truss, 400 ft. long, is provided and anchored at both abutments to provide against uplift under heavy loading. The Warren-type truss was selected because of the small number of primary parts and the interchangeability of duplicate members, which was a distinct advantage in view of the limited space available for storing and erecting at the bridge site. The panels are 9 ft. 2 in. long and 8 ft. deep; the width between trusses is 5 ft. This width of bridge was considered the maximum permissible without encouraging animals to turn around and cause confusion, with possible danger to tourist riders. Steel detailing of the truss members is shown in the accompanying drawing, together with the manner of anchoring at the abutments.

Because of the inconvenience large parties experienced with the limited loading allowed on the old bridge, the live load assumed for the new bridge was a continuous line of loaded pack animals, with an additional 40 per cent of this amount added for impact. This live load amounted to 100 lb. per linear foot of bridge and the dead load totaled 280 lb. The combined loads produced a maximum tensile stress of 103.8 tons on each of the two main cables.

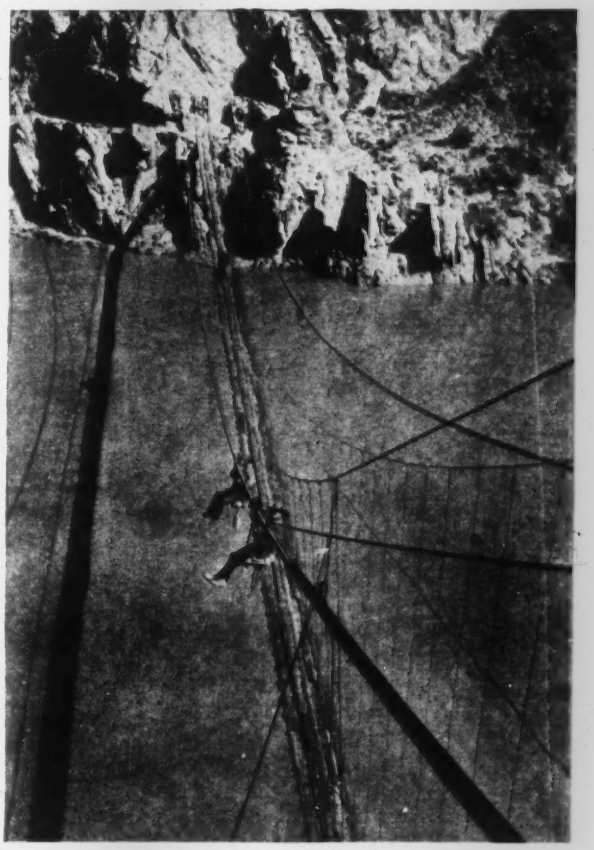
Assuming a factor of safety of 3½, this loading would have required single main cables approximately 3 in. in diameter. Such cables would be extremely stiff and difficult to transport down the narrow trail with many abrupt turns, with the added danger of having the galvanizing destroyed and the life of the cable thereby impaired. To minimize these difficulties four 1½-in. cables were adopted to form each of the two main bridge cables. Although these smaller diameter cables were much more flexible and greatly reduced the maximum load to be transported, the cost of moving them to the bridge site

nearly equaled their original cost at the factory. The combined strength of each group of four 1½-in. cables is 360 tons, which provides a factor of safety of 3.47.

The eight cables forming the main bridge supports are standard suspension bridge cables 548.45 ft. long composed of six strands on a wire core with seven wires to the strand. Each cable is heavily galvanized and weighs slightly more than 1 ton. These cables, as well as the ⅝-in. hanger cables, were all cut to exact length according to the design and had the sockets attached before being shipped from the factory. This insured the correct camber and the proper tension on each hanger cable by adjusting the main cables to their exact predetermined sag. The arrangement permitted adjustment by means of the individual bridge sockets and resulted in the additional improvement of securing equal distribution of load on the cable anchorages.

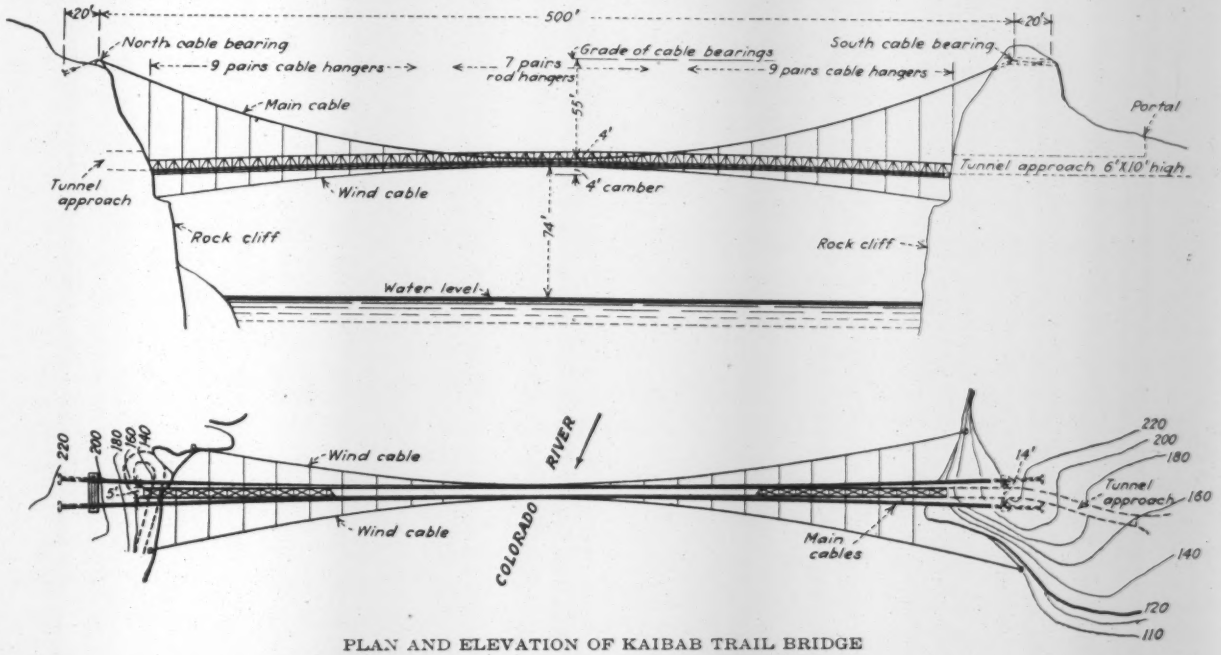
Provision against wind-sway consists of cable guys attached directly to the bridge at the center and diverging to upstream and downstream anchorages as shown in the accompanying plan. Cable ties connect these guys to the bridge at intermediate points to minimize secondary sway between the center and the abutments. To improve the effectiveness of these guys against any lifting force of the wind the anchorages were placed about 15 ft. lower than the point of attachment at the bridge center. These cable guys are 1½ in. in diameter and about 500 ft. long. A certain amount of rigidity is provided by the stiffening truss, but its narrow width compared to its length was not considered sufficient, in view of the unusual wind conditions, without the addition of the guy cables.

The floor consists of ¼-in. flat steel plates riveted rigidly to the floorbeams and covered by a 2-in. wearing surface of asphaltic concrete. This floor design gives additional stiffness to the structure and will reduce the maintenance costs common to the timber floor of the old bridge. The wearing surface consists of four parts of screened aggregate obtained at the site and one part of emulsified asphalt mixed with this aggregate and spread without the application of heat. Bringing the asphalt to the site presented another transportation problem. It was solved by packing the asphalt in 5-gal. tin containers at the refinery, these cans being convenient for delivery by pack animals.

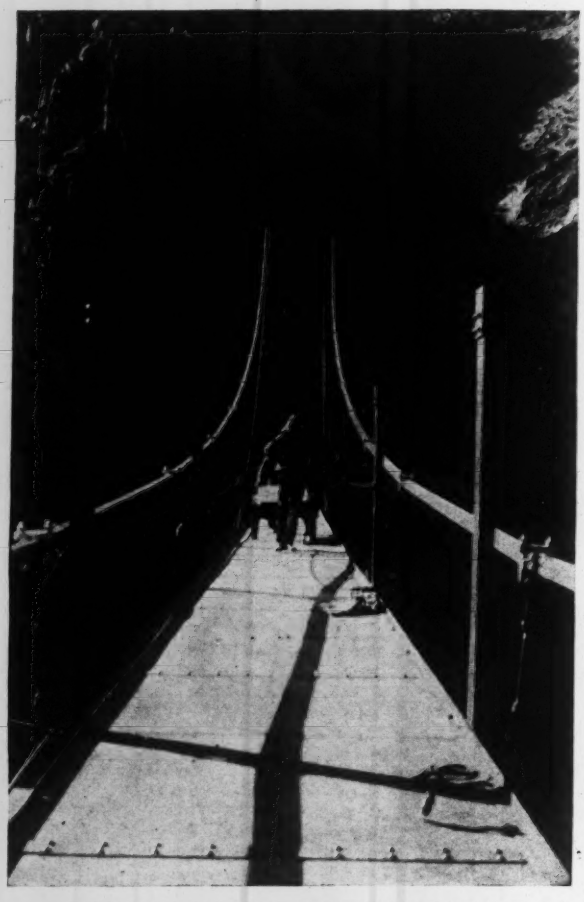


LAYING OFF HANGER INTERVALS ON MAIN CABLES
The old bridge used during construction is shown below.

Erection—The first step in erection required the transporting of 122 tons of materials and supplies from the terminus of truck transportation to the bridge site



PLAN AND ELEVATION OF KAIBAB TRAIL BRIDGE



STEEL PLATE FLOOR READY FOR ASPHALT
Angle irons at sides provide form for 2-in. surfacing.

down 7½ miles of trail having an average grade of 12 per cent. This work occupied a period of three months, and for a part of this time a maximum of seven packers and 42 pack animals was employed. Notwithstanding the awkward character of most of the loads, not a single animal was lost or injured. The eight main cables were unreeled and carried down the trail one at a time by a crew of 42 Indians, who made the round trip in two days; the load per man was about 50 lb. The wind cables were shipped in one piece on a single reel, and this was mounted on a skid with wheels under the rear end and dragged down the trail by horses. This method proved more economical, but was much slower than the employment of a crew of men.

The design called for the new cable anchorages 7½ ft. below the supports for the old bridge, making it impossible to use open cut excavation in the rock of the canyon walls. It was necessary to tunnel below the existing anchorage, the excavations requiring extreme care in blasting to avoid disturbing the old anchorages. Drilling for the anchorages was done by compressed air from two compressors of 80-cu.ft. capacity each. Use of the old bridge facilitated the stringing of the cables and they were raised to position and adjusted by means of a common hand-operated stump puller.

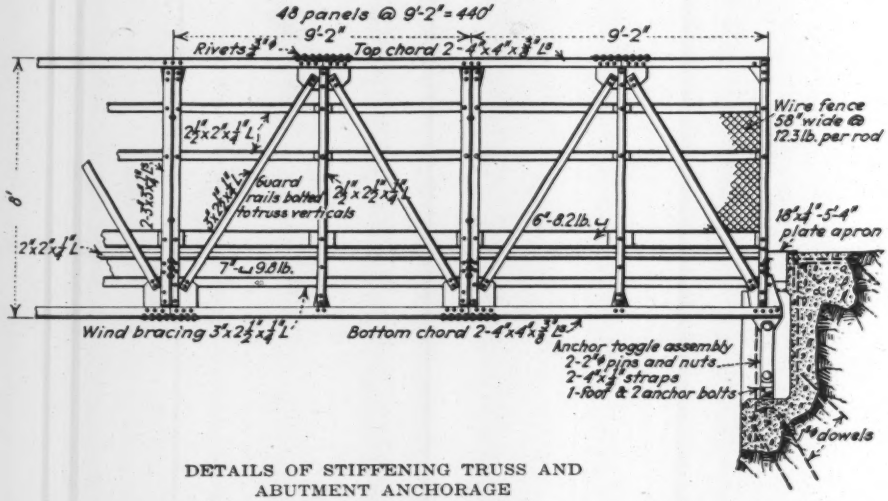
Following adjusting of the main cables, erection proceeded on the floor system and stiffening truss. Each panel, consisting of floorbeam and two verticals, was riveted together at the bridge site and transported by hand cart out on to the old bridge to its approximate position. After attachment was made to the hanger cables, the frame was raised to position and rigged into place by men suspended in slings from the main cables. The next step was to rig a high line over the center line of the bridge and to hoist the remaining material into place.

The floor system was riveted into two panel sections before taking it out on the old bridge for placing. The floor plates and guard angles were then bolted on, followed by the truss members. The wind cables were next connected and the main cables adjusted for final position. The wind cables then were adjusted to give the correct alignment. After these steps, the field riveting was completed and guard rails were bolted on. Wire fencing weighing 12.3 lb. per rod then was placed as a safety precaution along the sides.

Drilling for the abutment excavations and for the south upstream wind cable anchorage was accomplished with considerable difficulty, as the driller had to work while suspended in a rope sling. The wind cable anchorage was particularly inaccessible and it was necessary to swing the driller in a rope sling 125 ft. below the top of the cliff.

Two new approaches were provided to complete the improvement and increase safety. The south approach is through a tunnel 105 ft. long with a cross-section 6 ft. by 10 ft. high, as shown in the accompanying general view. This tunnel permits traffic to enter the bridge on a tangent and eliminates a dangerous section of trail along the face of a precipitious cliff. The north approach is provided by a spiral from the old trail under the new bridge up to the elevation of its abutment. These approaches have proved to be very effective and safe.

After completion of the new bridge, the old bridge was removed piece by piece, working both ways from the center, and the material was carried ashore and stored.



DETAILS OF STIFFENING TRUSS AND ABUTMENT ANCHORAGE

TRANSPORTING 1-TON MAIN CABLE TO SITE
A two-day trip for 42 Indians for each of eight cables.

Total cost of the new structure in place, exclusive of approaches, was $31,781.

The design and construction of the bridge was under the general supervision of the writer. The design was prepared by W. P. Webber, designing engineer in the San Francisco office of the National Park Service, and erection was in charge of J. H. Lawrence, construction engineer. The pack outfits were supplied by M. R. Tillotson, superintendent of Grand Canyon National Park. Cables were furnished by the Hazard Wire Rope Company, of Wilkes-Barre, Pa.

Distribution of Land Uses of Missouri Plateau

Land uses in the Northern Great Plains, or Missouri Plateau, also known as the spring wheat belt, an area of 130,000,000 acres in eastern Montana, western North and South Dakota, northeastern Wyoming and some adjoining regions, are thus classified in a report of the U. S. Geological Survey made public on Dec. 11, 1929: Irrigation ("includes irrigable and Missouri bottom land") 2,714,600 acres, or 2 per cent of the total; farming, 16,214,200, or 12 per cent; farming-grazing, 16,039,500, or 12 per cent; grazing-forage, 16,423,500, or 13 per cent; grazing, 69,652,000 acres, or 54 per cent; national forest, 8,718,000 acres, or 7 per cent. The area covered by the report "is almost as large as Germany and larger than all the New England States combined with New York, New Jersey, Pennsylvania, Maryland and Delaware." The report is a joint production of the departments of the Interior and Agriculture and contains many details not here mentioned, including data by counties and eight sectional maps. The maps may be obtained for 50c. each from the Director of the U. S. Geological Survey, Washington, D. C.; or all eight with complete text for $3.

Board Picks Alternative Routes for Colorado Aqueduct

Locations Require Pumping Lifts to Bring Water to Southern California—Costs Eliminate the All-Gravity Routes

RECOMMENDING the elimination of all the so-called gravity routes from further consideration and requesting more detailed engineering and geological information along four tentatively selected pumping routes, the board of review which is to select the most feasible route for the proposed aqueduct to bring water from the Colorado River to southern California on Dec. 21 rendered a preliminary report to the directors of the Metropolitan Water District.

The board, composed of Thaddeus Merriman, A. J. Wiley and Richard R. Lyman, as noted in *Engineering News-Record*, Sept. 12, 1929, p. 432, was appointed to select the aqueduct route from the 56 officially proposed locations or from the several others suggested by private engineers. Following a month's work, divided between field trips over the proposed routes and study of the engineering data assembled by the Los Angeles Water Bureau prior to the organization of the district, the board issued the preliminary report requesting more detailed data on several routes before reconvening to determine their final recommendation. Essentials of the preliminary report are given in the following:

Further Investigation Recommended

It was recommended that preliminary location surveys and more detailed geological investigations be made along four tentatively selected routes to permit of more accurate comparative cost estimates. These lines would all require pumping lifts of various heights and are described briefly as "(1) From Black Canyon to Puddingstone via Goffs, Ash Hill, Lucerne Valley and San Bernardino; the same by way of Morongo Valley and also via Barstow. (2) From Bulls Head to Puddingstone via Goffs, Ash Hill, Lucerne Valley and San Bernardino; the same by way of Morongo Valley and also via Barstow. (3) From Upper Parker via Rice and Cadiz to Ash Hill and thence along the several alternates to Puddingstone. (4) From Picacho to Puddingstone via Ruthven, Whitewater and Colton." [Entering the State of California, the first two of these routes follow in a general direction the main line of the Atchison, Topeka & Santa Fe Railroad toward Los Angeles with possible cutoffs suggested to eliminate the angle at Barstow. The third route follows approximately the Phoenix line of the same railroad, suggesting the same possible cutoffs. The fourth route begins a few miles upstream from the Southern Pacific Railroad crossing of the Colorado near Yuma and follows, in general, that railroad northwest toward Los Angeles.—EDITOR.]

In making further studies along any of the above routes, it was recommended that location work should take into consideration "*(a)* geological conditions; *(b)* accessibility to existing transportation lines; *(c)* value of rights-of-way; *(d)* minimum cost of construction; and *(e)* maximum future safety." In addition, the location, as far as practicable, should be selected with a view to the possibility of eliminating the various pumping lifts at a later date.

Extended consideration was given to four unofficial

routes as proposed by Jay Turley, Charles Kirby Fox, E. C. La Rue and Walter Gordon Clark, but in each case the route was eliminated from further consideration. The first two of these schemes are essentially the same and consist of an 850-mile aqueduct from above the Grand Canyon to include irrigation supplies for Utah and Nevada; this general plan was considered "outside the range of present-day possibilities."

The plan of Mr. La Rue for an 875-ft. dam at Bridge Canyon so far exceeds any existing or contemplated structure "that we consider it too hazardous to be attempted" and when the other features of this scheme were studied the result indicated, in the board's opinion, that "this plan is not a practical present solution of the district's problem."

The proposal of Mr. Clark for a straight-line tunnel from Black Canyon dam site to deliver a supply by gravity at an elevation of 450 ft. would necessitate some pumping at the lower end to supply certain parts of the district. While admitting several advantages of this plan, including the short route and the advantage taken of the Black Canyon reservoir, the final conclusion eliminated it from further consideration chiefly because of tunneling difficulties. An additional hazard pointed out was the fact that the line would cross the San Andreas fault under a cover of approximately 5,000 ft.

The effect of the Virgin Valley salt beds on the quality of the water was considered, but "the water will not take up enough of this salt to produce any objectionable consequence." However, it was recommended that because of the prominence given to this subject, further examination of the salt areas be made, although it was believed "that these salt exposures can be rendered impotent by the simple expedient of covering them with a blanket of earth placed by steam shovel."

Silt Problem Presents Difficulties

The silt problem presents a number of difficulties which require further study. It was recommended that the district engineers study the silt problems further, including the methods used in silt removal at other diversion points along the river. Suggestion was made that the aqueduct location should provide for the possibility of future treatment works along the line; this precaution would not add to the present cost, but would guard against the future need for such provision.

Further geological studies along the routes recommended were requested with a view to classifying rock at tunnel locations for a more accurate estimate of costs. "The main rift of the district known as the San Andreas fault cannot be avoided by any aqueduct from the Colorado River." Because of this fact it was considered advisable that the aqueduct line at the point of crossing be at or near the ground surface.

Apparent advantages of a dam across the river at either Bulls Head or Upper Parker are sufficient to justify additional surveys and examinations at these points so that data would be available for later accurate cost estimates. Provision for terminal storage at the end of the main aqueduct line was considered of great importance, and detailed study of various suggested sites was recommended. The Puddingstone reservoir site was tentatively selected as the terminus for all the proposed routes, but more detailed study may change the location of the lower end slightly. The possibility of intermediate storage along the aqueduct line was considered of sufficient value to warrant study as to the possibility of providing a reasonable volume. It is recommended that the proposed locations be considered with a view to securing such possible storage.

In the light of all considerations "the only present practicable supply of water from the Colorado River is to be obtained as a pumped supply through an aqueduct so located as to take full advantage of the topographical features of the country through which it passes, always keeping the pump lifts down to the lowest practicable minimum and bearing in mind the desirability of connections which may be made in the future for the purpose of eliminating all or a large part of the pumping lift."

Government Must Pay Damages in Boeuf Floodway

Federal Court Decision in Kincaid Suit Holds That Guide Levee Construction Amounts to Taking of Floodway Lands

AS REPORTED in brief in the news pages of our issue of Dec. 19, 1929, p. 983, the court proceedings brought by a landholder in the proposed Boeuf floodway, which the government is undertaking to build in Louisiana and Arkansas as part of the Mississippi flood-control scheme, ended in a decision adverse to the government on Dec. 13. Judge Ben C. Dawkins, of the Federal District Court at Monroe, La., granted an injunction against the Secretary of War and other government officers, restraining them from building the guide levees of the floodway until provision has been made for compensating the owners of land in the floodway.

The decision hinged on the question of whether the land would be damaged by the floodway construction, and the court held that the testimony shows that damages would result. It was conceded by the attorneys for the government that no attempt had been made to condemn or buy the land, and that funds had not been provided for payment of damages or purchase of the land. Their contention was that no additional destructive floodwaters would be placed upon the land, and that the flood-control act of May 15, 1928, under which the work is being prosecuted, requires the United States to provide flowage rights only for "additional destructive floodwaters that will pass by reason of diversions from the main channel of the Mississippi River."

As the cost estimates on which the present project is based were made without including any damage payment to landowners in the Boeuf and Atchafalaya floodways, the decision, if sustained, means a great increase of costs and may necessitate complete reconsideration of the floodways planned, possibly including economic comparison between wide and narrow floodways. Because of the importance of the decision some essential passages are quoted below.

The property involved lies about midway between the guide levees on the east and the hills on the west, which are from 10 to 12 miles apart. The west guide levee will end just below the city of Monroe, which is some 40 miles northwest of complainant's land, while the one on the east will extend a few miles south of his property.

This condition [exposure of the land to the waters of the Boeuf, the Macon and Tensas rivers, as well as to the Ouachita and Black rivers to the south of the land in question—EDITOR] causes backwater to accumulate in the area immediately south of complainant's property, and will continue to do so after construction of the proposed guide levees. When the Mississippi reaches such a stage that the fuseplug levee just below Arkansas City will break, under the plan, about one-third of the total

volume of water passing that point at the time will be turned down the Boeuf floodway and into the area just described.

When the water in the Mississippi reaches 60½ ft. it will begin to flow over [the fuseplug levee just below Arkansas City, at the head of the Bœuf floodway—EDITOR]. It is contemplated that this will cause a crevasse through the fuseplug levee, which will gradually widen to include the whole of 20 miles if the condition of the Mississippi requires. The former Chief of Engineers and author of the project stated in his examination before the flood-control committee of the House of Representatives that the soil of this piece of levee would be softened with sand or otherwise, to be sure that it would break without undue danger to those above and below, although the government's chief hydraulic expert in his testimony in this case stated that he did not so understand the purpose.

With a flood at the maximum contemplated by the plan, the quantity of water passing down the Boeuf basin, it is estimated, will be between 900,000 and 1,250,000 sec.-ft., with the result that complainant's property as well as all other lands therein will be submerged. The depth, of course, will vary according to the conditions and stages of water in the Mississippi, the Tensas, Black and Ouachita rivers at the time, but may reach a maximum of approximately 16.4 ft. on the plaintiff's land.

In the opinion of some of the engineers, the velocity will not be very great, but will be sufficient to destroy the buildings and improvements in the floodway which are not anchored to the ground. The duration of the water upon these lands will also depend upon conditions prevailing in the lower Mississippi Valley, including the Ouachita, Black, Red and Atchafalaya rivers, but will probably be from 30 to 60 days.

Too Great Burden on Landowners

Contrasted to these conditions with which plaintiff and others within the floodway will have to deal, those fortunate enough to own property behind the levees will be fully protected, including their improvements, livestock, etc., and can pursue their farming and other activities in perfect safety. Those within the floodway will live under a constant menace, for no one can tell in what years meteorological conditions will require the use of their lands for the purpose intended by the plan—that is, a floodway. The government engineers estimate that this will probably not happen more than once in twelve years, while evidence offered on behalf of the plaintiff tends to indicate that in the light of past experience it might occur once in every four or five years. However, as pointed out in the former opinion in this case, there is no escape from the proposition that the complainant's property and that of all others similarly situated will be, by express design of the plan, compelled to bear the whole burden whenever the necessity arises.

So long as their lands, along with those of all other property owners in the Mississippi Valley, were subject to the uncontrolled action of the elements and were dependent upon the strength or weakness of the constructions upon the main stream of the river, they were in no greater danger and were compelled to bear no heavier burden than anyone else. But when the government departed from the policy of building levees and other public works for the purpose of commerce and navigation alone and expressly entered the field of controlling floods for the protection and reclamation of private lands, then it became engaged in activities which make it responsible for the invasion of private rights. The very basis of the plan is that by strengthening and increasing the height of the existing levees the excess water shall be diverted over property within the floodways.

I think it reasonably clear that when the plan is completed the property within the floodways can be cultivated in most years, but always, of course, with the knowledge that a flood may come and cause the owners or operators to suffer serious loss. However, these are elements going to the amount or value to be paid for the rights; for the act clearly indicates that the government may acquire either in fee simple the land desired or merely a servitude or right of flowage in those cases where nothing more is needed. It is admitted that the defendants do not contemplate prosecuting any proceedings for the condemnation of flowage rights through the Boeuf basin or that they will endeavor to acquire them amicably from the owners.

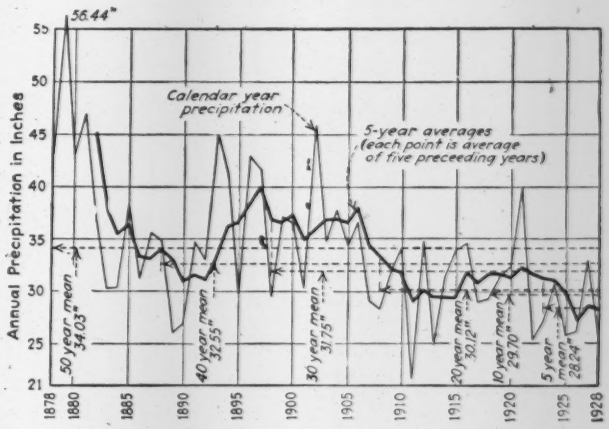
Of course, the physical occupancy of the ground in this case will not take place until and when it is overflowed by water in time of flood; but the process of subjecting it to that service and the taking possession in so far as is either necessary or contemplated by the act will begin with the construction of the first levee or works which are intended to direct the water upon the land. It cannot be that if the owner is entitled to compensation he must wait until an overflow comes.

My conclusion is that the act requires the government to pay for the rights which it seeks to exercise over plaintiff's property, and in so far as the defendants are proceeding without complying therewith, they should be restrained.

Fifty-Year Rainfall Record at Seattle Shows Long Decline

THE long-term rainfall record for Seattle shows a downward trend that has continued for many years. This is of present interest in view of the recent severe drought in that region. W. C. Morse, consulting engineer, of Seattle, has supplied the accompanying 50-year diagram. In explanation he says:

"This is a calendar year record. Storms that come during December and January may, on occasions, combine the heaviest precipitation of two successive seasons in the record of a single calendar year, thus building up some very sharp peaks. To offset this I have established



FIFTY-YEAR RAINFALL RECORD AT SEATTLE, WASH.

a five-year average built up by taking the mean of the five years immediately preceding each successive year of record; this gives a much less ragged curve.

"The water situation in the Northwest is more serious than is commonly recognized. Groundwaters are much lower than any previous record, and while groundwaters do not directly govern the flow for hydro-electric use, yet they do affect the demand for power by requiring pumping against higher heads.

"Water for hydro-electric power is largely obtained from the winter snowfall and later from the glacial flow. The glaciers, without any exception that I know of, have receded materially in the past few years and the flow therefrom is gradually getting less and less.

"The recession of a glacier is very slow, of course, but to offset that its growth is still slower, so that for the next few years at least it may be expected the hydro-electric plants must depend more and more on the runoff that comes directly from rainfall and snowfall, rather than runoff fed from glacial flow.

"Data for the accompanying diagram, which were taken from U. S. Weather Bureau reports, include records kept privately for the years 1887 to 1890 but subsequently corrected by the bureau and used as part of its record."

New Railway Planned for British Columbia

Preliminary surveys have been made for a railway, to be built by English capital, between Pelkwa and Vanarsdal, two points on the Canadian National Railway, in the central part of British Columbia.

Durability of Portland Cement

A Test for Distinguishing Between Cements and for Determining Their Relative Qualities of Permanence

By Thaddeus Merriman
Chief Engineer, Board of Water Supply, City of New York

Solubility of lime from cement in a cane sugar solution parallels the disintegration of the cement in sodium sulphate solution. As the reaction is modified by effect of the dissolved lime, the sugar solution is first treated with a definite amount of lime. Titration with acid using methyl orange indicator shows a larger solution value than titration using phenolphthalein; the difference between the two values is a measure of the silica, iron and alumina in the cement. This difference closely checks the disintegration behavior, and the author offers it as a test of durability of cement. The durability is also closely paralleled by the alumina content, satisfactory durability being shown when the alumina content was below 5.8 per cent. The cements tested are the 32 cements compared by Committee C-1 of the American Society for Testing Materials. —Editor.

IT HAS come to be generally recognized that the strength of portland cement concrete is not a measure of either permanence or durability under conditions of outdoor exposure. Similarly, strength alone does not serve to indicate the resistance of a cement to the disintegrating influences of the alkali salts. Miller[1] has shown wide differences in the ability of concretes made from different cements to resist alkali attack, and other investigators have reported similar findings. Every engineer has seen portions of a concrete structure disintegrate at an early age while other parts of the same structure showed every evidence of continuing permanence and durability. Differences such as these can be satisfactorily accounted for only by predicating that cement differs both from brand to brand as well as from time to time within a particular brand. Portland cement meeting the so-called standard specification is not so uniform and unvarying a product as the consumer has generally come to believe.

Variations in Durability

Between two concretes mixed in the same proportions with aggregates of unquestioned quality with equal quantities of water the only conceivable difference affecting their permanence and durability must be sought in the quality of the cement used. While two such concretes may show equal strength, the one may be greatly superior to the other in durability. The commonly used cement specification is based almost wholly on tests of strength and gives no clue to the important quality of permanence. The concrete field cylinder merely repeats the story of the laboratory test. High early strength may indeed be a symptom of later weakness.

Durable concrete for outdoor exposure can be made only from cement having such inherent characteristics that it will develop hydration products which will remain permanent and continue to resist the disintegrating influences of the environment in which the concrete is placed. The determination of these characteristics is one of the important needs of the engineer whose concrete is exposed to sunshine, rain, heat and cold, in all of their many combinations and effects. His concrete must also, in many situations, resist the solvent effects of percolating water as well as the destructive action of the salts which that water carries in solution.

The market affords cements which are highly resistant to disintegration, while in others this quality is only partly developed. Between the extremes there are many degrees of quality, yet all of these cements compete with one another and sell at the same price. The intrinsic value of some cements is therefore much greater than that of others. The engineer needs a test that will enable him to determine this quality of resistance, in order that he may be enabled to select that cement which will best serve the purposes of his work.

Solubility in Sugar

In a previous article[2] the author reported the results of certain tests which had for their objective the determination of the differences in the characteristics of portland cements. Since that article was written many additional experiments have been made, and the subject has now been advanced to the point where the results seem to warrant the presentation of a test for the durability of portland cement.

This test is based on the well-known fact that solutions of cane sugar are able to dissolve relatively large quantities of lime. If, then, a portion of the dry cement to be tested is put into such a solution, the amount of cement dissolved should, if all other conditions are equal, be a measure of the ease with which the cement is broken down by the sugar solution. In other words, the less the cement is dissolved the more strongly does it resist the action of the sugar solution, and, inferentially, the more completely have its combinations been completed; that is to say, the more thoroughly has it been manufactured. The sugar solution used in the author's tests always contained 15 grams of sugar in each 100 c.c. of water.

The quantity of a cement dissolved by a sugar solution is readily determined by neutralizing it with an acid of known concentration and measuring the quantity required for that purpose. In these investigations ½-normal hydrochloric acid was used, and the number of cubic centimeters necessary to neutralize 25 c.c. of the water-15 per cent sugar-cement solution has, as in the article above referred to,[2] been termed the "solubility" of the cement.

Tested in this manner, wide differences among different cements were disclosed as indicated in the accompanying table. Columns 2 and 3 show the solubilities of 32 different cements using, first, phenolphthalein and, second, methyl orange as the indicator for determining the end point of the titration. Each figure for the solubility represents the number of cubic centimeters of

[1] Dalter G. Miller—"Resistance of Portland-Cement Concrete to the Action of Sulphate Waters as Influenced by the Cement," *Proceedings*, American Society for Testing Materials, 1928, Vol. 28, Part II.

[2] "New Studies in the Properties of Portland Cement," *Engineering News-Record*, Oct. 23, 1924, p. 669.

DIFFERENCES IN CEMENTS AS SHOWN BY TESTS

Cement No.	Solubility in 15% Sugar Solution: Phenolphthalein	Solubility in 15% Sugar Solution: Methyl Orange	Solubility in 15% Sugar Plus Lime Solution*: Phenolphthalein†	Solubility in 15% Sugar Plus Lime Solution*: Methyl Orange†	(5) Minus Column (4)	Condition in 10% Sodium Sulphate at 2 Months‡	Condition in 10% Sulphate at 5 Months‡	Per Cent of Alumina
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2	2.9	3.1	10.5	11.7	1.2	OK	OK	3.79
20	4.5	5.0	16.6	19.7	3.1	OK	OK	4.26
31	10.3	11.6	19.7	24.3	4.6	OK	OK	4.64
32	4.0	4.5	21.0	25.9	4.9	OK	OK	4.98
26	1.8	1.8	15.4	20.5	5.1	OK	F	4.74
12	2.8	3.0	19.4	24.8	5.4	OK	OK	4.29
28	8.6	12.2	20.0	25.6	5.6	OK	F	5.43
23	3.4	3.7	20.4	26.2	5.8	OK	B	5.72
11	2.7	3.1	20.9	27.3	6.4	F	..	5.65
29	3.3	3.5	22.5	29.2	6.7	OK	OK	5.56
4	3.3	3.6	18.6	25.4	6.8	F	..	5.84
14	4.6	5.2	24.8	31.6	6.8	B	..	5.80
18	12.6	18.2	24.9	32.4	7.5	B	..	5.32
25	9.2	13.2	22.3	30.3	8.0	B	..	6.65
24	3.5	3.8	25.8	34.0	8.2	B	..	5.92
30	10.3	15.3	21.9	30.1	8.2	B	..	6.24
19	11.6	16.6	23.3	31.5	8.2	B	..	5.90
10	6.1	8.0	21.4	29.6	8.2	BBBB	..	6.39
9	2.7	3.0	22.3	30.6	8.3	BBB	..	5.70
6	14.3	19.8	27.7	36.1	8.4	F	..	5.21
8	12.0	17.5	23.2	31.9	8.7	BB	..	6.07
7	5.6	7.8	22.5	31.2	8.7	BBB	..	7.22
5	14.4	20.8	24.8	33.9	9.1	BB	..	6.14
15	4.3	5.4	24.6	3.8	9.2	BB	..	6.66
13	3.8	5.4	25.5	35.7	10.2	BB	..	6.99
22	16.3	24.0	28.9	39.4	10.5	B	..	6.53
3	17.7	24.9	27.2	38.2	11.0	BB	..	6.86
1	20.7	30.3	31.2	42.3	11.1	BB	..	7.28
27	13.7	22.0	27.1	38.3	11.2	BBB	..	7.32
21	10.7	15.4	24.9	36.3	11.4	B	..	6.93
16	15.5	22.7	27.3	38.8	11.5	BB	..	5.97
17	17.3	25.1	28.7	40.5	11.8	F	..	6.46

*This solution contains such quantity of lime that 5 c.c. of ¼-normal hydrochloric acid are required for neutralization, using phenolphthalein as the indicator.
†All figures in these columns represent the total number of c.c. of ¼-N hydrochloric acid required to neutralize the 15% sugar + lime + cement solution.
‡The symbols in these columns have the following meanings: OK = Good. F = Fair. B = Bad. BB = Very bad. BBB = Extremely bad. BBBB = Completely disintegrated. Where no symbols are shown, the specimens were removed at two months.

½ normal hydrochloric acid required to neutralize 25 c.c. of the 15 per cent sugar solution in which 7½ grams of the cement had been agitated for two hours. The differences indicated are large and striking and emphasize the fact that cements are far from being alike in their constitutions and combinations. The results in columns 2 and 3, however, are so variable that no satisfactory analysis of them has been possible and they are here presented merely for the purpose of emphasizing the great differences in resistance which various cements exhibit when subjected to the same conditions of test. It is to be noted, in passing, that the larger values of the solubilities tend to group themselves near the bottom of the table.

Modifying Effect of Lime

The above procedure having proved inadequate for the purpose intended, the significance of the differences disclosed was importantly developed when it was discovered that the quantity of cement which the sugar would dissolve was in large measure proportional to the amount of lime easily taken into solution up to the point where the indicated solubility was from 4 to 5. Beyond that value for the solubility all of the cements continued to dissolve, each at its own characteristic rate, while for smaller values of the solubility equilibrium was soon attained and the cement strongly resisted further solution. This finding suggested that the differences shown in columns 2 and 3 were not to be entirely ascribed to the fundamental qualities of the cements but rather to the fact that the test would not start them all off from the same plane unless the sugar solution was brought up to an initial alkalinity of 5 by the preliminary addition of lime. It thus appeared that the addition of lime would increase the power of the sugar solution to dissolve the cement and that this action was analogous to that of a key unlocking a door. The causticity of a lime-sugar solution acts to unlock the combinations of a cement and thus to render it more soluble. The more completely a cement has been manufactured and the more closely its combinations have been perfected the less of it will be dissolved by a lime-sugar solution.

The solubility of each of the cements was then determined in a 15 per cent sugar-lime solution in which sufficient calcium hydrate had been dissolved to produce an initial alkalinity or indicated solubility of 5. Two titrations were made for each cement with different indicators and the results are shown in columns 4 and 5. It was then noted that the differences between the values in columns 4 and 5 ranged from 1.2 to 11.8, and the order of arrangement in the table is that of these differences, the smallest being at the top of the table. The effect of the initial causticity is evident in the greater amount of the cement which was dissolved, as shown by the greater solubilities observed. It is also to be noted that the range of differences has been leveled out. The figures in columns 4 and 5 include the initial causticity of 5 of the sugar-lime solution.

Comparison of 32 Cements

The 32 cements reported are those which were tested by 52 co-operating laboratories under the auspices of Committee C-1 of the American Society for Testing Materials[3]. Those who are interested in the relationship between strength and quality may compare the order of these cements in the table with the results reported by Committee C-1. Arranged in the order of strength, these cements take on a very different grouping from that indicated in the table, if, indeed, any grouping is possible.

In addition to the sugar solubility tests on these 32 cements, each of them was also tested by immersion of neat poured briquets at seven days in 10 per cent solutions of sodium sulphate. The results of these tests at two and at five months are shown in columns 7 and 8, and it at once appears that only those cements having low values for the difference between the solubilities shown by the two indicators came through this severe exposure test. The concordance between the results of the sulphate test and the difference between the solubilities is so striking as to leave practically no room for doubt as to the value of this indication as a measure of cement durability. It may therefore be reasonably concluded that this test is a practical measure of the ability of a cement to resist disintegration under sulphate attack and under outdoor exposure.

Relation to Alumina Content

It is to be noted further that the alumina content of the cement as shown in column 9 also seems to have a bearing on the conclusion above stated, since it appears that the cements showing the lower values for the differences between the solubility were, in general, those which had the lower content of alumina. Taking this fact into consideration, it may be said that those cements which will make the most permanent concrete are those which show the smallest solubility difference and which carry the least alumina.

The difference between the solubilities as shown by the two indicators may be termed an index of disintegration;

[3]Report of Committee C-1 on Cement, *Proceedings*, American Society for Testing Materials, 1928, Vol. 28, Part I.

the greater the value of the index the more rapidly will disintegration occur. In the table it appears that only nine of the 32 cements came satisfactorily through the two-months sodium sulphate test. The limiting value of the disintegration index for these nine, with only one exception, is close to 5.8, while the limit on the alumina content is about 5.70.

"Index of Disintegration"

This test for resistance to disintegration is based on the following considerations: When the sugar-lime-cement solution is titrated in the presence of phenolphthalein, the quantity of acid necessary to reach the end point is a measure of the total quantity of lime in the solution. Similarly, when the same solution is titrated in the presence of methyl orange, the quantity of acid necessary to reach the end point is a measure not only of the total quantity of lime but also of the silica, the iron and the alumina which the solution contains. The difference between the values of the solubilities for the two cases is therefore a measure of the silica, the iron and the alumina which the sugar-lime solution has taken up from the cement. Chemical analyses have shown that the titration with phenolphthalein is an exact measure of the lime present in solution. These same analyses, however, disclosed widely variable quantities of silica, iron and alumina for the different cements. Electrometric titrations and hydrogen-ion concentration determinations on the sugar-lime-cement solutions have confirmed the main results of the chemical analyses as to the indication of the lime content in the presence of phenolphthalein as well as those of the titrations with methyl orange. Further and more detailed data as to these matters will be presented in a subsequent article.

For those who may be interested in making this test and in comparing results with those which have been presented, the following outline of procedure is recommended:

Dissolve 150 grams of cane sugar in 1,000 c.c. of distilled water. Add 25 grams pure lime hydrate; shake and let stand over night. Filter and titrate 25 c.c. with phenolphthalein as the indicator. The number of cubic centimeters of acid required to neutralize the dissolved lime will be about 26. Compute the amount of 15 per cent sugar solution which must be added so that the resulting solution will contain an amount of lime which will require exactly 5 c.c. of acid to neutralize 25 c.c. in the presence of phenolphthalein. Test to verify the result and make adjustments as necessary. The quantities stated will make about 5,000 c.c. of the sugar-lime solution.

Put 100 c.c. of this standard sugar-lime solution into a Nessler tube; then add 7½ grams of the dry cement to be tested; cork tightly and shake for two hours. Then filter and titrate 25 c.c. of the filtrate with phenolphthalein and 25 c.c. with methyl orange. The number of cubic centimeters of acid required for neutralization in the first titration subtracted from the number required in the second will then be the disintegration index.

For all titrations use ½-normal hydrochloric acid.

The specimens for the sodium sulphate exposure tests are, preferably, the broken ends of neat cement briquets made up with 43 per cent of water, as described in a previous article.[2] The 10 per cent sodium sulphate solution should be calculated to the anhydrous salt—that is, due allowance should be made for the water which the salt itself contains. At least 150 c.c. of solution should be allowed for each whole briquet and it should be tested from time to time by titrating 25 c.c. with the ½-normal acid in the presence of phenolphthalein. When the alkalinity of the solution becomes such that 5 c.c. of the acid are required for neutralization, the solution should be renewed. This is an important consideration because, as the reaction between the cement and the sodium sulphate proceeds, sodium hydrate is formed until the reaction is entirely inhibited. A weak solution in which the products of the reaction are removed may thus be more destructive than a strong one in which the reaction products are permitted to accumulate.

This test is a simple one. It can be accurately performed by any boy of average intelligence who has completed a high school course in chemistry, and less apparatus of smaller cost than that needed for the making of tensile tests is required. Many tests may, moreover, be completed in one day. The cane sugar used is the granulated "Domino" of the grocery store, while the ½-normal acid can be made up in quantity at any laboratory for a nominal cost or can be obtained on order from any chemical supply house.

Interpretation

This test is essentially a measure of the extent to which the constituents of a cement have been combined, in that it determines their resistance to the action of the sugar-lime solution. It is, therefore, a criterion of the completeness with which a cement has been manufactured. The test, moreover, is quantitative—that is to say, it will determine degrees of resistance. In this respect it differs from the ordinary soundness test, which merely indicates that a cement is sound but can never determine whether it is *nearly unsound*. A cement (as, for instance, No. 5 in the table) which did not have its combinations as thoroughly completed as did another (cement No. 31) could not develop the same kind of hydration products and therefore failed in the sulphate test. The essence of this matter of durability lies in such complete manufacture that the cement will, when made into concrete, develop durable and resistant hydration products. Partly made cement cannot produce enough of these products to protect the body of the concrete.

The pendulum of interest in portland cement is showing a definite trend away from the long-held belief that cement, wherever it be made, is a uniform and unvarying product and toward the more rational understanding that cements do in fact differ and that some method for distinguishing one from another is a necessity. The day is not far distant when the engineer will be able to specify his cement as he now does the steel which makes his bridges and other constructions possible. A specification for steel which was silent as to carbon, yield point and elongation would lead to variations of the same order and degree as those which daily occur in portland cement under the specification which is called standard.

The researches leading up to the development of this test for durability were carried on under the direction of the author in the laboratory of the Board of Water Supply by L. Bernard Stebbins, assistant to the chief engineer, and by Richard H. Gaines and Nathan Goodman, chemists. The electrometric titrations and hydrogen-ion concentration determinations of the sugar-lime-cement solutions were made by Wilbur G. Parks, of Columbia University.

Tall Concrete Buildings

South America is the most sensational adapter of the concrete building idea, the Hotel Palacio Salvo at Montevideo, Uruguay, being the highest building of its type in the world, says the *Lawrence Dragon*, New York, in its issue for January. It rises to a height of 28 stories, with its peak 338 ft. above the sidewalk level. The tallest concrete building in the United States is the Master Printers Building, New York City, which has twenty stories and an over-all height of 310 ft.

Sewage Farm Displaces Filter Beds at Vineland, N. J.

Borough Leads Eastern Municipalities in Irrigation of Crops With Sewage — Farm Operated Under Five-Year Lease

By George A. Mitchell
Sanitary Engineer, Vineland, N. J.

SEWAGE irrigation of crops has been practiced in Bunzlau, near Breslau, Germany, and in Edinburgh, Scotland, for centuries. In this country it is practiced in California and Texas. In the Eastern states several institutions and municipalities tried this method of disposal many years ago, but for one reason or another abandoned the practice. An article by the writer in *Engineering News-Record*, Feb. 14, 1924, entitled "Studies of Outlets and Crops on Sewage-Irrigated Areas," describes successful sewage irrigation at several public institutions. Most of these have continued the practice and some new systems have been installed.

The first municipality to adopt sewage irrigation of crops as a result of the experimental work described in my previous article is Vineland, N. J. For years this borough, now of about 8,000 population, disposed of its sewage on sand filters located near the borough boundary. In later years the final effluent was chlorinated before its discharge into a small stream flowing into a pond about 6 miles distant, from which water was pumped for the city of Millville.

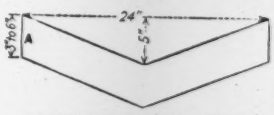
Owing to complaints about the beds by near-by residents, it was decided in 1928 to pipe the raw sewage a distance of 2½ miles to a very sandy area where a settling tank and sludge-drying beds were built. The tank effluent flows through a terra cotta pipe to the fields to be irrigated. These fields comprise 50 acres of Maurice River sand, recently cleared and grubbed.

The borough of Vineland contracted with a farmer to dispose of the effluent from the settling tank on this borough-owned land for a period of five years, with a salary for the first two years only. His compensation for the last three years of the life of the contract must come from the crops grown. In making the contract it was assumed that farming would probably be done at a loss for the first two years, because of the extreme poverty of the land and the fact that the soil was full of the roots of trees, briars and huckleberry bushes. The first year's operations bore out this forecast in that a financial loss was sustained from farming operations. However, a good yield of sweet potatoes of excellent quality and moderate yields of sweet corn, egg plant and rhubarb were obtained on this sterile soil, with the use of no fertilizer except sewage. Nothing is grown for human food that is not cooked before eating.

SEWAGE-IRRIGATED CABBAGE, VINELAND, N. J.
Grown for feeding to poultry only.

ASPARAGUS WITHOUT AND WITH SEWAGE IRRIGATION
Left—Limed and fertilized only. Right—Irrigated with sewage. It is not necessary to apply sewage during the cutting season.

The sewage-distribution system is very crude, consisting of ditches. An efficient distribution system would have made less land clearing necessary and would have greatly lessened the labor of caring for the sewage in a sanitary manner. A terra cotta pipe line was laid by the contractor along one side of the field. Three valve boxes govern the flow into three distribution ditches. The methods of distribution from the ditches had to be devised chiefly by the farmer. The first year certain level places were found along the banks where furrows were made, 3 ft. apart, at right angles to the ditch, so that, by making an earth dam, the sewage flowed out fairly evenly in 30 or 40 furrows. Pieces of sheet iron, 2x8 ft., were cut into sections (see sketch), and set in the bank of the ditch, one for each furrow. The leveling of these outlets could be done by eye, after considerable practice, while the sewage was flowing.



SEWAGE DIVERTERS
Cut from sheet iron. Dimension *A* varied according to slope. When land near ditch is flat a height of 3 in. gives good results. When slope from ditch is sufficient to cause a rapid wash a height of 5 or 6 in. is better.

When set properly these sheet-iron pieces made it possible to divide accurately the total flow among a given number of furrows. But sometimes washouts occurred, in which case gullies were formed and a large amount of the sewage from the ditch flowed through the break. To avoid washouts and make the outlets permanent considerable care had to be taken in setting the sheet-iron piece. It was necessary to set all those used at one time at the same elevation. Washouts were less likely to occur if the sheet iron was inclined toward the ditch.

The amount of sewage which will produce maximum crops of different kinds has yet to be learned. There are many other problems relating to sewage distribution and crop planning, also of chemistry, bacteriology and economics, that call for a solution before the possibilities of sewage irrigation for crop production can be determined. A study of these problems has recently been arranged through a co-operative investigation to be conducted at Vineland by the U. S. Department of Agriculture and the New Jersey Agricultural Experiment Station.

Fig. 1—Circular Cell Cofferdam for Construction of Deadman Island Dam on Ohio River

Circular Cell Cofferdam on Deadman Island Dam

Seventy-eight Units 40 Ft. in Diameter and 40 Ft. High Built for Long Overflow Dam Across Ohio River at Shields, Pa.

By William H. Fowler
Secretary, Dravo Contracting Company, Pittsburgh, Pa.

A CIRCULAR cell cofferdam of the same type as that used in raising the U. S. battleship "Maine," consisting of 78 units, 40 ft. in diameter, built of 40-ft. sheet-steel piling, was used in constructing the Deadman Island dam on the Ohio River at Shields, Pa., 13½ miles below Pittsburgh. The project is part of the government's 9-ft. waterway development of the Ohio River and will be of great advantage to the heavy traffic in the upper pools by the elimination of interruptions at the old dam No. 3, about 2½ miles above, and dam No. 4, about 5 miles below Deadman Island dam. The dam, of the overflow type with an ogee section, is 1,585 ft. long between the abutment and outer face of the lock structure, which is located on the left bank of the river. Resting on solid rock bottom, the dam is about 38 ft. high with a vertical upstream face, and has a crest width of 4½ ft. and a base width of 60 ft.

The type of cofferdam selected was the result of much study in the engineering office of the contractor, and it is believed to be the first application to construction work of the type used in raising the "Maine." Because of the length of the dam, the cofferdam was built in five rectangular sections, each section inclosing an area 80 ft. wide and varying in length from 210 ft. to 498 ft. For raising the "Maine" the inclosure was elliptical in plan, 350x170 ft. The cylinders were 50 ft. in diameter, built of 35-lb. steel sheet piles spliced to 75-ft. lengths, driven to a penetration of 38 ft. through soft material, the cells being filled with mud dredged from clay shoals in Havana harbor and banked on the inside of the cofferdam with heavy riprap. For the Deadman Island dam cofferdam the cylinders were driven to rock, filled with sand and gravel to the top and had no interior banking.

The strength of the sheet pile grip was of such vital importance to the success of the cofferdam that it formed the subject of considerable study and testing in the purchase of material, and careful inspection of the driving and pumping. In selecting sheets for use, wide grips were rejected and the sheets were driven with the narrowest end of the grip at the bottom. Appreciable variation was found in the width of groove on individual sheets.

Cofferdam Construction—A general plan and profile of the cofferdam and details of its construction are shown in Fig. 3. Each cell is 40 ft. in diameter and consists of 100 steel piles of 38.6-lb. straight section, each 40 ft. long. Adjacent cells were placed 2 ft. apart, each gap being closed with two curved sheet pile diaphragms and connected by means of T-piles to the walls of the cells as detailed in Fig. 3. All pockets of the cofferdam were

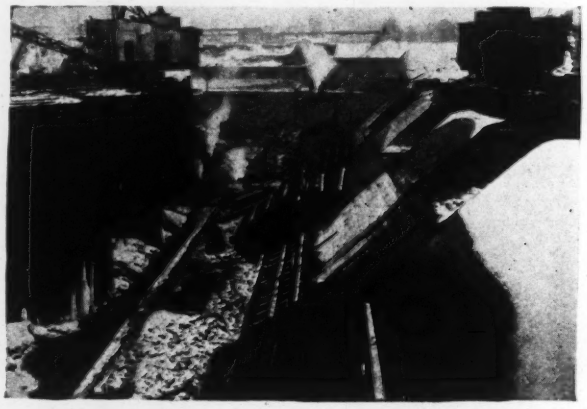


FIG. 2—INTERIOR OF COFFERDAM
Abutment in background. Temporary openings in top of dam for river passage shown at right.

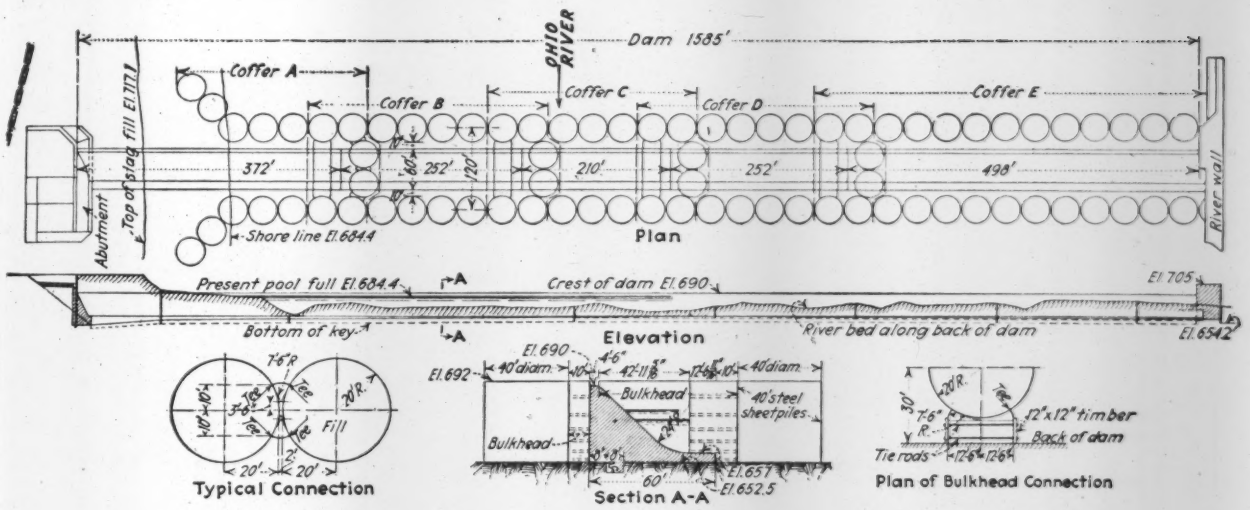


FIG. 3—GENERAL COFFERDAM LAYOUT WITH DETAILS OF UNIT CELLS, JOINTS, BULKHEADS AND DAM CROSS-SECTION

filled and banked on the outside with material dredged from the river with clamshells, but no banking was used on the inside. A minimum distance of 10 ft. was maintained between the inner walls of the cells and the faces of the dam, allowing enough room for a waterway and space for form building.

Driving of the sheet piles to form the cofferdam was accomplished with swinging leads carried by the boom of a full-circle crane mounted on a barge, a type of derrick boat developed by the contractor. Accurate form and alignment of the cofferdam were of special importance, and were achieved by driving the sheet piles around a templet of heavy timber construction, which was floated to position and secured to a section of the cofferdam previously completed.

In spite of the utmost care, about three or four sheets out of 8,000 were driven out of the groove due to encountering boulders, and had to be redriven. In one case the resulting rupture was discovered before pumping; the others were not discovered until considerable pumping had been done. In each case the pocket was emptied and about four or five sheets on either side of the rupture were removed and redriven.

The construction program originally contemplated six sections of cofferdam, each about 250 ft. long, and built successively; the first at the abutment and the last at the river wall of the lock. This procedure was carried out except that the last two sections were built as one, 498 ft. long. Each section of cofferdam was removed as soon as the inclosed work was completed, so that the sheeting could be used repeatedly. This required the construction of bulkheads across the end of the completed work to form a closure for the next section. These bulkheads were wooden box cofferdams with sides, of 3-in. tongue-and-groove sheeting, 25 ft. apart and supported by 10x12-in. wales and tie rods. The sides of the bulkhead were built-in. slabs closely fitted to the faces of the dam and in sections of such lengths as to be easily handled by cranes for subsequent re-use.

The cofferdam was remarkably tight. After un-

FIG. 4—BUILDING SECTION OF COFFERDAM

Note type of equipment used, full-circle cranes on barges driving sheeting and filling cells, and same type of cranes on wide-gage tracks on top of completed portion excavating interior of cofferdam.

watering, the 498-ft. section, under a 30-ft. head, was kept dry with one submerged 15-in. centrifugal pump driven by a 100-hp. motor. After the completion of the inclosed permanent construction, the sheet piles were removed by a pile extractor carried by the boom of the revolving crane derrick boats.

The advantage of this type of cofferdam is readily apparent from the accompanying illustrations, which show clearly the accessibility of the interior to floating plant and the facility of conducting the construction operations with cranes traveling on wide-gage tracks laid on the top of the cofferdam, unobstructed by timber bracing.

To provide for the passage of the water while the construction of the last section of the dam is in progress, twenty sluiceways were left to be closed as the final operation in the completion of the dam. These sluiceways are 10 ft. deep and from 16 ft. to 22 ft. wide, providing 399 lin.ft. of weir opening. Bulkheads of 12x12-in. timbers placed horizontally with calked joints have been provided to close the sluiceways, allowing a 2-ft. space along each side of the neat lines of the concrete to allow for building the forms. The sluiceways will be unwatered by means of steam siphons.

The work on the construction of the first cofferdam was commenced in September, 1928, and the first concrete was poured on Nov. 17. The work was interrupted several times by usual winter floods, the river stage rising above the top of the cofferdam nine times between Dec. 1 and May 27. In all, 53 working days were lost, though much additional time was consumed in clearing away the mud and debris left by the receding water after each flood.

Except for high water interruptions the work has proceeded favorably and will be completed well ahead of the contract time limit. Unusually fast progress was made in constructing the last cofferdam section. This section was commenced on July 21 and completed on Aug. 22. It includes 498 lin.ft. of dam and consists of 22 cells with their connecting bulkheads. The abutment, located on the right bank of the river, was commenced in September, 1928, and was completed in five months. It rests on a foundation of two caissons, one 75x27 ft., and the other 78 ft. 3⅝ in.x29 ft. in plan, and 33 ft. deep below pool level, and 66 ft. below top of ground to bedrock.

The project is under the jurisdiction of Col. H. B. Ferguson, division engineer, Corps of Engineers, Cincinnati, Ohio. Lieut.-Col. Jarvis J. Bain, district engineer, Pittsburgh, has had direct supervision of the work. The Dravo Contracting Company, Pittsburgh, Pa., holds the contract for building the dam, the abutment, the lockgates and the emergency dam for the lock chamber.

One-Way Concrete Slab Floors Widely Used in Northwest

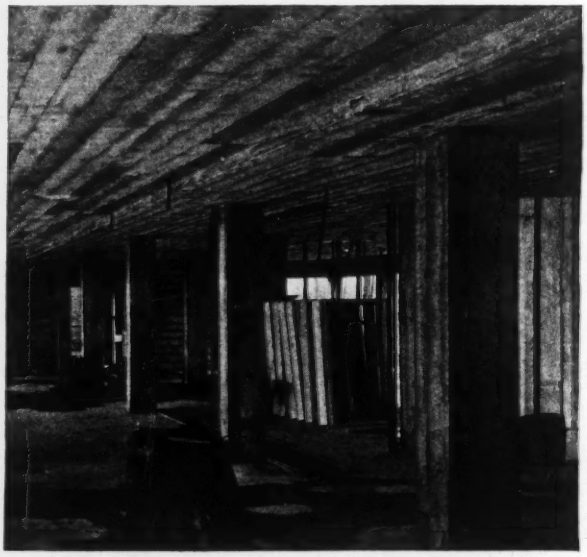
Trend in Design Influenced by Simplicity, by Savings in Story Height and in Cost of Forms and Plastering

By George Runciman and H. L. Worthington
Structural Engineers, Seattle, Wash.

In recent years in the Pacific Northwest there has been a pronounced development in the use of one-way concrete slab floors in buildings of the hotel, office, apartment, hospital and similar light-load types. In the following presentation of the merits of this form of floor system design it is not intended to advocate its unlimited and unrestricted use under any and all conditions. It is the intent, rather, to draw attention to a type of concrete floor which is admirably suited to certain buildings.

The concrete slab reinforced in one direction is, of course, one of the oldest and simplest elements of reinforced-concrete structures, but a distinctive feature in the construction that is coming into extensive use in the Northwest is the use of one-way slabs for spans whose length might be thought to require a different type of framing. Spans ranging up to 20 ft. are built in this manner, the slab itself extending the full distance between supports without beams or other stiffening members. Particularly in those buildings whose architectural arrangement naturally adapts them to a layout of three spans—a central corridor span flanked by wall spans—the one-way slab floor has proved itself very well suited.

Considering first the unfavorable aspects of floors of this type, there are the increased amount and consequent increased costs of both concrete and steel reinforcement and also the increased column and foundation loads. By these additions to cost, however, there is effected the great saving in the cost of plastering which results from applying in one operation and directly to the bottom of the slab the "hard" finish plaster coat, thus eliminating the other operations and the other plaster coats.



FLOOR SYSTEM IN RHODODENDRON APARTMENTS, SEATTLE

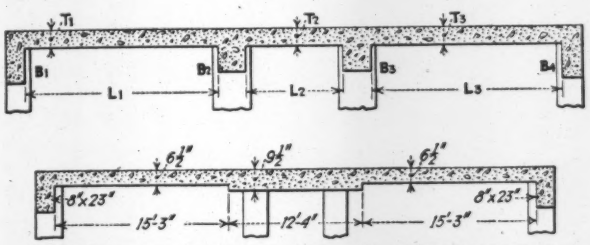
On the other hand, factors favorable to one-way slab floor systems are: simplified formwork, easy placement of reinforcement and of concrete, superior quality of concrete, flat ceilings and minimum story height. An evaluation of these different elements furnishes the data on which to base comparative cost estimates.

In applying the "hard" plaster directly to the concrete floor slab, the more truly smooth and horizontal the slab bottom the easier and less expensive the plastering will be. Therefore, tight and unyielding forms are desirable, and the care that is taken with the forms to obtain a true plane slab bottom is amply repaid in simplified plastering. There is no advantage in appearance or otherwise in

BUILDINGS IN WASHINGTON HAVING ONE-WAY CONCRETE SLAB FLOORS

Building	Stories	City	Year	B_1	B_2	B_3	B_4	L_1	L_2	L_3	T_1	T_2	T_3
St. Vincent's Home	4	Seattle	1922	8 x26	10 x24	10 x24	8 x26	16'- 3"	8'- 1"	16'- 3"	6½"	6½"	6½"
Olympic Hotel*	12	Seattle	1923	18 x16½	11½x20	11½x20	18 x16½	15'- 2"	18'- 7"	14'- 2"	5"	5½"	5"
McDermott Apts.	7	Seattle	1925	8 x21	12 x20	12 x20	8 x21	17'- 4"	18'- 0"	17'- 4"	7"	7"	7"
Charbern Apts.	8	Seattle	1925	8 x38	16 x16	16 x16	8 x38	17'- 3"	16'- 8"	17'- 3"	7½"	6½"	7½"
Vance Hotel	10	Seattle	1926	6 x42	36 x12	36 x12	6 x36	10'- 7"	11'- 4"	11'- 8"	5"	5"	5"
Lloyd Bldg.	10	Seattle	1926	6 x40	30 x15	30 x15	6 x40	10'-10"	10'-11"	11'- 0"	5½"	5½"	5½"
Stratford Hotel	7	Seattle	1927	8 x39	12 x18	12 x18	8 x39	13'- 3"	15'- 9"	14'- 0"	5¼"	5¼"	5¼"
Rhododendron Apts.	9	Seattle	1927	See accompanying sketch.									
Providence Nursing School	5	Seattle	1927	12 x22	12 x22	12 x22	12 x22	16'- 7"	8'- 0"	16'- 7"	7"	7"	7"
Virginia Mason Hospital	6	Seattle	1920	8½x36	15 x24	15 x24	8½x36	13'-10"	7'- 3"	13'-10"	7½"	7½"	7½"
Dawnland Maternity Inn.	6	Seattle	1928	6 x42	30 x12	24 x12	6 x42	16'- 0"	6'- 1"	14'- 7"	7"	4½"	6½"
Dunlap Apts.	6	Seattle	1928	8 x25	12 x18	12 x18	8 x25	12'- 4"	15'- 7"	13'- 4"	5½"	5½"	5½"
Emerson Apts.	10	Seattle	1928	8 x40	14 x17	14 x17	8 x40	12'- 6"	11'- 3"	12'- 6"	5"	5"	5"
Lowell Apts.	11	Seattle	1928	8 x21	18 x18	18 x18	8 x21	14'- 3"	17'- 2"	13'-10"	6"	6"	6"
Joseph Vance Bldg.	14	Seattle	1929	6 x45	24 x14	30 x15	6 x45	14'- 9"	9'- 0"	16'- 3"	6"	5"	7½"
Fairview Apts.	5	Seattle	1929	8 x18	17 x16	17 x16	8 x18	16'- 0"	4'-11"	16'- 0"	6½"	6½"	6½"
St. Joseph Hospital	5	Bellingham	1927	8 x18	10 x18	10 x18	8 x18	13'-10"	8'- 1"	13'-10"	5"	3"	5"
Cascadian Hotel	10	Wenatchee	1929	7½x18	13 x18	13 x18	7½x18	15'- 9"	16'- 2"	14'- 9"	6"	6"	6"
Broadmoor Apts.	7	Tacoma	1929	8 x24	13 x18	13 x18	8 x24	16'- 6"	11'- 7"	15'- 8"	6½"	4½"	6½"
Metaline Falls Hotel	4	Metaline Falls	1929	8 x28	15 x14	15 x14	8 x28	13'- 0"	11'- 5"	13'- 0"	5"	4½"	5"
Community Hotel	15	Bellingham	1929	8 x30	12 x20	12 x20	8 x30	15'- 0½"	12'-11"	15'- 0½"	5½"	5½"	5½"

*Used 1:1:2 mix in floors.



SECTIONS OF FLOORS LISTED IN ACCOMPANYING TABLE

making the plaster coat thick; on the contrary, the job will be made better and cheaper by keeping the plaster as thin as possible. Similarly the bond between the plaster and the structural concrete slab depends upon the adherence at the plane of contact of the two materials, and this is practically unaffected by plaster thickness. On the other hand, a thin plaster coat, weighing less than a thicker one, tends less to break down and disrupt that bond. For these reasons it is desirable to keep the plastering as thin as possible.

Formwork for the one-way slab calls for a flat, unbroken surface, which is the simplest kind of a form to build. Beams occur at the columns in one direction only. Built in a sufficiently substantial manner, the one-way slab form constitutes a working platform on which other construction processes can go forward with maximum facility.

Electrical conduits are embedded in the slab and are run in any direction. Being in slabs of considerable thickness, the conduits can be crossed and overlapped without difficulty and they do not impair the strength of the slab.

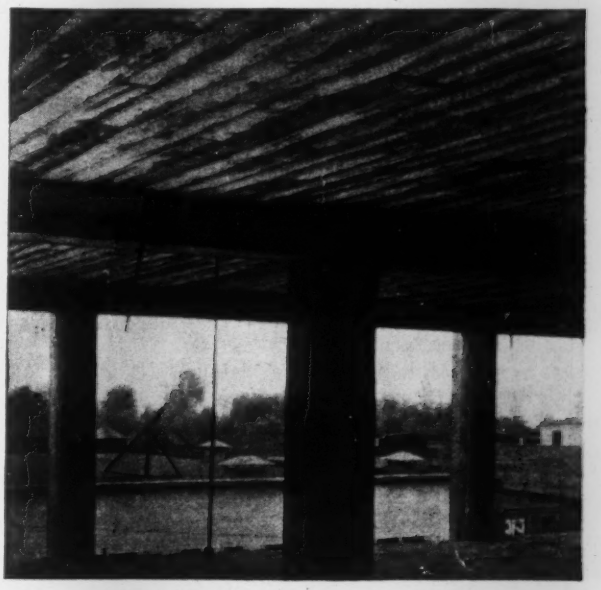
The placement of the slab reinforcement is a clean and simple operation, since there is no necessity to space closely or to crowd the bars. If the bar spacing be held to some commonly accepted maximum, such as one and one-half to two times the slab thickness, fewer bars, of larger diameter, will be required in the long-span one-way slabs than in thinner slabs of shorter spans; consequently the unit cost both of reinforcement and of placement of reinforcement is somewhat reduced.

The placement of the concrete also is a relatively simple operation, since it does not have to be worked into the confines of narrow members, but can be deposited more or less in mass. This in turn makes it possible to use a somewhat drier concrete and a stiffer consistency than would be desirable for placement in smaller members. The unit costs of concrete are favorably influenced both by the increased quantity and by the conditions of simple placement. Concrete of better quality may be expected because of the better placement, better curing and less rapid drying out that attend the use of the fairly thick, heavy sections.

Holes for the passage of individual pipes through the slabs are provided by tacking light metal sleeves to the forms and filling them with sand before the slab is poured. Where plumbing is concentrated in regular stacks, rectangular openings are provided. Where the length of such openings is in the direction of the slab spans, additional reinforcement at the sides of the opening in most cases will adequately meet this condition. If the length of the opening lies squarely across the slab span, it may prove necessary to employ small marginal stiffening beams, although these are to be avoided, if possible.

The flat, unbroken ceiling afforded by the one-way slab is in practically all cases an architectural desideratum. There are spandrel beams at the walls and, at the columns, lines of beams in one direction only. These interior beams are usually in line with partitions. All else is flat ceiling.

An appreciable saving in story height is made with the one-way slab, because the thickness of the structural floor in the room is that of the slab only, whereas with other types of floor it is the thickness of a thinner slab plus the



TYPICAL FLOOR SYSTEM USING ONE-WAY REINFORCING

GROUND FLOOR OF ELEVEN-STORY APARTMENT

depth of the supporting members. The saving of several inches per story gives a considerable saving when expressed as a total applied to the height of all walls, stairs, vertical plumbing, etc.

Being equally stiff in all directions, the one-way slab is efficient for carrying concentrated loads and distributing them over a wide breadth. It also forms a strong, stiff plate for the distribution of the horizontal loads that come upon a building.

Such a floor, acting as a column for the distribution of horizontal loads, may not possess the stiffness that a deeper floor of the ribbed or joist type would have, yet, in view of its elastic curvature established by the vertical loads upon it and in view of the distribution of load which its constant uniform thickness makes possible, it is probable that the one-way slab floor is as effective for the distribution of horizontal loads as any floor built.

In resistance to flexure, the constant depth makes it as well suited to "negative" as to "positive" moments. Although shallower than other floors, a proper disposition of the reinforcement in conjunction with its full effective breadth enables it to meet the same conditions of loading, under the same stress conditions, as do other floors.

For the bracing of higher buildings employing this type of floor, wall construction of reinforced concrete is well adapted. Such walls, properly designed and integrally connected to the floor systems, act as vertical webs and are capable of great structural service.

Since the plaster of the finished ceiling is applied directly to the bottom of the slab, any cracks occurring in the concrete will appear through the plaster. Cracks practically never occur transverse to the main reinforcement, but may develop parallel to it if sufficient secondary-temperature or shrinkage-reinforcement is not used. It is therefore advisable to use such secondary reinforcement in fairly liberal measure.

A list of some of the more important buildings recently built in the State of Washington in which one-way slab floor systems have been used is given in the accompanying table.

Canadian Town Responsible for Deaths Due to Polluted Water

KINGSVILLE, ONT., has been held to be guilty of negligence in the epidemic of typhoid fever occurring there in the spring of 1927, and the husband of one of the victims of the epidemic has been granted $2,000 damages with costs by an Ontario court.

Kingsville is a town of about 2,400 inhabitants, situated on the shore of Lake Erie. The typhoid outbreak consisted of about 50 cases, of which ten or more proved fatal. The opinion of the court is printed in *The Canadian Engineer* of Sept. 17, 1929.

Until 1927 the water supply was drawn from the lake through an intake pipe extending 1,600 ft. from the shore. Ten years earlier the chemist in charge of the experimental station of the provincial department of health had reported gross pollution of the lake and recommended: (1) chlorination of the water supply without delay; (2) filtration; (3) sanitary sewers and some simple method of sewage treatment.

Notwithstanding numerous requests by the provincial health department, the Kingsville authorities took no action until 1921, when they applied to the department for permission to construct additional storm sewers. Permission was refused unless the town would undertake to filter its water supply. The council agreed to this, and in that year water filters were installed, but no provision was made for chlorination.

In 1926 the water in Lake Erie was exceptionally low, and the town decided to replace the 30-year-old intake pipe with a new one, to be extended 400 ft. farther out into the lake. This project was approved by the voters of the town, but before it could be completed the old pipe line failed completely in February, 1927. To admit water to the settling basin near the shore line, the superintendent, with the approval of the local public utilities commission, broke a hole in the outer face of the basin below the water level and dug a trench from the hole out some distance into the shallow water of the lake. Realizing the fact that grossly polluted water was entering their plant and that the sand filters would probably not be adequate protection, the local board of health inserted a notice in the local papers and distributed a hundred handbills advising that all water should be boiled to make it safe for drinking purposes until a new intake could be installed. The use of the trench was continued some weeks after the ice had disappeared from the lake.

The first case of typhoid developed on April 1 and the epidemic continued well into the month of June. On April 14 a temporary automatic chlorination plant was installed by the district provincial water officer. This apparatus was replaced by a permanent installation in June.

The court considered it to be a double and significant coincidence that the outbreak of the epidemic was within a few days after the disappearance of the ice from the lake and while the town water supply was still being drawn through the open trench, and that the epidemic abated shortly after the chlorination was started. Approval of filtration without chlorination by the provincial board of health in September, 1922, did not detract from the responsibility of the local health authorities in using the open trench to admit water to the sedimentation basin. The court realized that the town had been compelled to adopt emergency measures to insure a supply for fire protection, but there was nothing to prevent the immediate installation of an automatic chlorination plant. The evidence was that it could have been done within 24 hours and that the subject of chlorine treatment had been under discussion between the provincial board of the town officials for ten years, so that the latter had not been taken by surprise. The court also held that the notices and handbills warning water users to boil the water were entirely inadequate and that every householder should have been warned of the dangerous character of the water.

Development Tests on a Light Floor for Bridges

Slab Weighing Only 57 Lb. Per Square Foot, Armored and Reinforced by a Special Structural System of T's and Flats, Carries Equivalent Highway Loads on 4-Ft. Span

By Leon S. Moisseiff
Consulting Engineer, New York City

THE requirements of modern vehicular traffic demand roadways and pavements having uniform, continuous and hard surfaces. They must offer sufficient friction to prevent skidding, and should be of permanent character to require as few repairs as possible. Roadways of bridges, in addition, should also be fireproof. These requirements can easily be met, but the weight of such roadways is a serious factor; the more weight a bridge has to carry the more material will be required to build it. Engineers, therefore, are confronted with the problem of building strong and permanent roadways on bridges with the least dead load, for weight becomes a determining factor in long-span bridges.

This is readily illustrated: A roadway having a concrete foundation of 8 in. and a granite pavement of 4 in. will weigh about 155 lb. per square foot. For a roadway 40 ft. wide, this will mean 6,200 lb. per linear foot of bridge, a very substantial load to support and more than twice the live load on the same roadway. Engineers, therefore, as a rule omit the granite pavement on long-span bridges in spite of its excellent wearing qualities, and substitute a surface of lighter weight. At the time when vehicular traffic was mostly horsedrawn and wheel concentrations of trucks were naturally much smaller than those of today, wood-block pavement supported on steel buckle plates was used on long-span bridges because of its light weight. But under present-day heavy traffic, this type has proved inadequate. The heavy concentrations distort the buckle plates and break the concrete filling. The wood blocks swell and shrink under atmospheric changes. Asphalt pavement, while almost twice as heavy as wood pavement, 30 lb. per square foot, may still be considered light pavement, but it requires a solid floor foundation.

To reduce the weight of roadway floors, engineers have endeavored to utilize a minimum thickness of floor to support the surface pavement. Several years ago the writer designed for the Delaware River bridge a roadway floor slab of a total thickness of 6 in., in which are embedded steel reinforcing trusses 4½ in. deep placed 6 in. on centers. The reinforcing steel could thus be held definitely in place and a thin cover (¾ in. of concrete) could be used. At the same time the steel web members of the reinforcing truss took care of the comparatively heavy shear caused by concentrated loads. This floor has proved perfectly successful. Tests of large slabs, 20x20 in., made at Washington jointly by the Delaware River bridge engineers and the Bureau of Public Roads, furnished interesting information and showed the great efficiency in distribution and strength of this form of slab. This slab weighs 85 lb. per square foot without an asphalt surface.

The writer is of the opinion that no lighter underfloor than this could be made of stone or gravel concrete

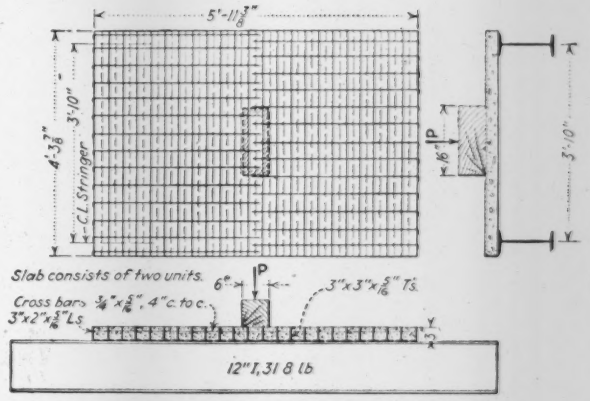
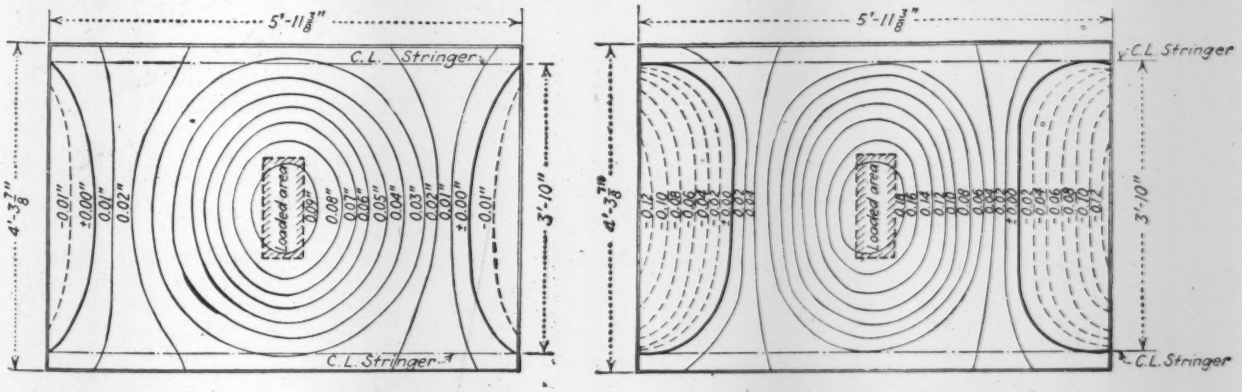


FIG. 1—DETAILS OF TEST SLAB NO. 1
Note that slab is built in two halves with the crossbars staggered and projecting into each of the halves beneath the concentrated load.



Deflection Contours Produced by a Central Load of 20,000 Lb. Contour Intervals $\frac{1}{100}$ Inch

Deflection Contours Produced by a Central Load of 30,000 Lb. Contour Intervals $\frac{1}{50}$ Inch

FIG. 2—DEFLECTION CONTOURS PRODUCED BY CONCENTRATED LOADS AT CENTER OF SINGLE SPAN

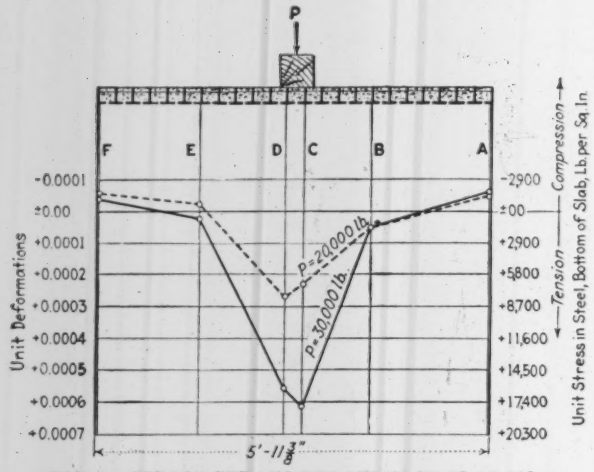


FIG. 3—STRESS-STRAIN RELATION IN SLAB NO. 1

which would be adequate for the requirements of modern traffic. As will be noted, the slab forms a foundation only and should have either a pavement or a wearing surface of concrete. While any pavement laid on the concrete slab may easily be repaired, this is not the case with a concrete wearing surface. To repair a wearing surface of concrete, a depth of 2½ to 3 in. is required, which the reinforcing steel would not permit.

Engineers have desired to reduce still more the weight of the roadway slab and its wearing surface, and the writer has recently made some tests on a special floor that gives every appearance of meeting some of these desires. It consists of small T-irons laid adjacent to each other so as to form a continuous steel surface on the bottom. These T's are transversely connected by bars mechanically pressed together, forming on top a steel grating with rectangular openings. This steel structure is filled with concrete flush with the top of the grating. No formwork is required, as the horizontal metal offers a solid surface. What is obtained is a unit slab of steel cells filled with concrete. With a view toward developing this type of construction to the greatest possible degree, full-size tests of the slab were made at the testing laboratories of Lafayette College, Easton, Pa., by William S. Lohr and George F. Roehrig.

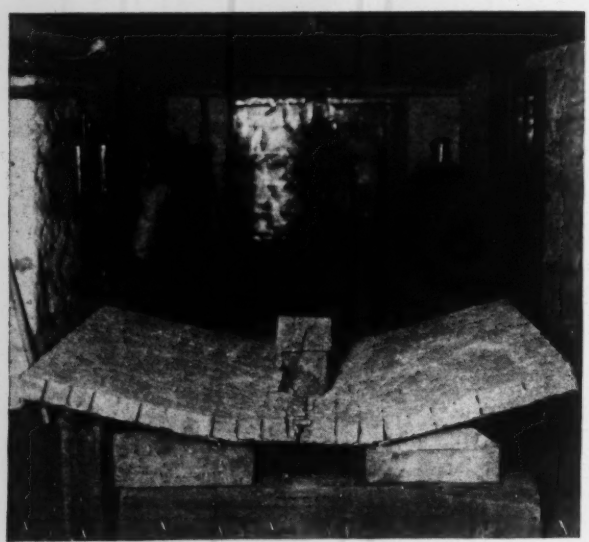


FIG. 4—TWO HALVES OF SLAB NO. 1 PLACED TOGETHER AFTER FAILURE IN TESTING MACHINE

Two test slabs were built, one to show the behavior as a single span and the other as a span continuous over three supports.

Test Slab 1—Test slab 1 was made of 3x3x$\frac{5}{16}$-in. T's of structural steel, laid close to each other to form a series of troughs. The vertical webs were locked with $\frac{5}{16}$x$\frac{3}{4}$-in. crossbars spaced 4 in. It was aimed to determine experimentally the deflections in the slab when acting as a simple beam. The span was made 3 ft. 10 in., being the longest span that could be fitted into the testing machine, and the length of the slab was made 6 ft. in order to obtain the full phenomena of dishing under a concentrated load. The slab, therefore, was made 4 ft. 4 in. wide and 6 ft. long. There is no machinery available at present to fabricate the steel structure in widths greater than 3 ft., and since it was also thought advisable to test the monolithic strength of two pieces built in the field and held together by the embedded concrete, the slab was made in two halves; the crossbars projected from one half into the other as shown in Fig. 1.

The concrete filling was a ¾-in. gravel mix of 1:2:3, hand mixed; the slab was then vibrated by an electric

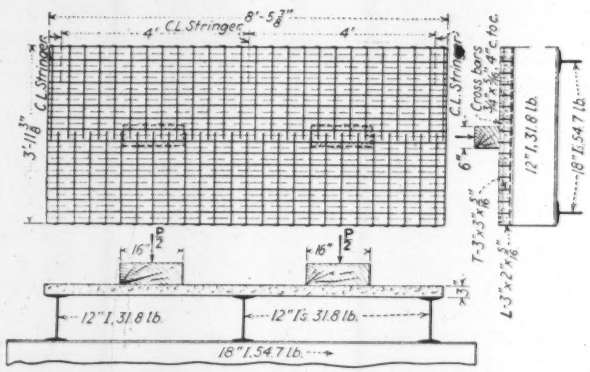


FIG. 5—DETAILS OF TEST SLAB NO. 2 CONTINUOUS OVER A CENTRAL BEAM

hammer. Standard test cylinders developed an average 28-day compressive resistance of 3,220 lb. per sq.in. The slab was tested at an age of 28 days.

Test slab 1 was placed in a testing machine on two 12-in. I-beams 3 ft. 10 in. on centers and the load was placed in the center of the slab through wood bearing pieces 6x16 in., simulating the bearing area of a twin tire of a heavy truck. At load increments of 2,500 lb. deflections and steel strains were read, deflections at 30 points and strains (on 8-in. lengths) at 25 points. Fig. 2 shows the deflection contours produced by a central load of 20,000 lb. at intervals of 0.01 in. and by a 30,000-lb. load at intervals of 0.02 in. The former illustrates well the characteristic behavior of the slab and the dished form it assumes. It clearly shows the support given by the adjacent length. The latter illustrates the effect of the increased load: Larger deflection has developed and the dished surface has narrowed in width, while the supporting effect of the adjacent portion of the slab has become more marked.

The stresses under the corresponding loads are plotted in Fig. 3, where the strain measurements on the central line of the slab as well as the corresponding unit stresses in the steel, based on a modulus of 29,000,000 lb., are given. It will be seen that the greatest stress measured in this slab under a concentrated load of 30,000 lb. was 17,700 lb. per sq.in. in tension. It should be added here that the slab was designed for a concentrated load of 20,000 lb., resulting in a computed stress of 1,000 lb.

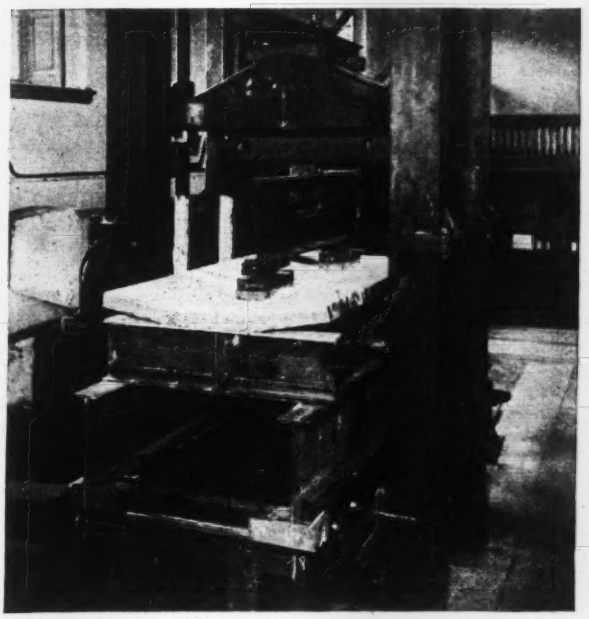


FIG. 6—TEST SLAB NO. 2 CARRYING ITS GREATEST TEST LOAD

per sq.in. on the concrete in compression, which was the limit value allowed on the slab; the stress in the steel figured low because of excess material in the T's.

Under a load of 40,000 lb., failure of bond between steel and concrete began to be indicated. What may be called the yield point as indicated by the scaling of the steel of the two middle T's was reached at a load of 55,000 lb. Distinctly visible cracks appeared on the upper surface of the concrete under a load of 68,300 lb. On the basis of the conventional method of computing concrete beams, this would correspond to a stress of nearly 3,300 lb. per sq.in. on the concrete in compression. The maximum load was reached with 71,520 lb. At that time the middle T's under the load had separated about ¾ in. The two halves of the steel, held together by the concrete as described in the above, did not separate before their removal from the testing machine. Fig. 4 shows the two halves of the broken slab put together for purposes of reproduction.

Test Slab 2—To study experimentally the effect of a continuous slab laid over several steel beams, themselves elastic, and also to observe the behavior of the slab where negative moments will be produced, test slab 2 was designed. It was exactly the same as slab 1, except for plan dimensions. It was placed on three 12-in. I-beams, 4 ft. on centers, forming two equal spans of 4 ft. each continuous over a center beam; as shown by Fig. 5. The load was applied simultaneously in the center of each span through wood bearing pieces. At intervals of 10,000 lb. (5,000 lb. per span) readings of deflections and strain measurements on the steel were taken. Altogether deflections were measured at 42 points and strain measurements were observed on 8-in. lengths for each individual loading. Fig. 7 shows the deflection contours at intervals of 0.01 in. produced by central loads of 20,000 lb. and 30,000 lb. on each span.

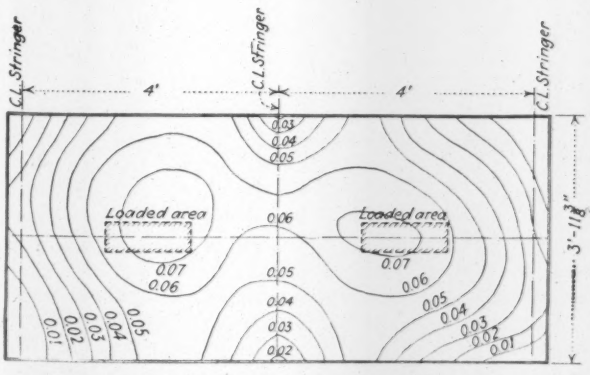
The stresses under the corresponding loads are plotted in Fig. 8, where the strain measurements on the central line of the slab as well as the corresponding unit stresses in the steel are given. It will be noted that the greatest stress measured in this slab under a concentrated load of 30,000 lb. in each span was 13,400 lb. per sq.in. in compression and less than 12,000 lb. in tension.

Failure of bond between steel and concrete began to be indicated at both ends under a load of 80,000 lb., or 40,000 lb. on each span. What may be taken as hair cracks or tension cracks were noticed on the surface of the concrete over the middle support under a load of 70,000 lb. Diagonal tension cracks appeared in the concrete on the top surface of the slab at 140,000 lb.

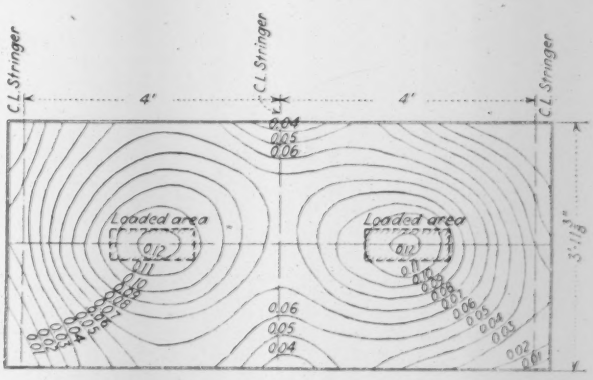
The yield point of the steel as indicated by scaling on the bottom of the T's was observed under a load of 150,000 lb. At the same time compression cracks began to appear on the top surface of the slab near the loading blocks. The maximum load was reached with 159,220 lb. At that time the six middle T's only were bearing on the supporting beams. The two halves of the steel, held together by the concrete, did not separate before the removal from the testing machine.

The test shows that a slab continuous over three supports developed an ultimate breaking strength of practically 80,000 lb. applied in a concentrated form.

Conclusions—The loadings described and illustrated here were selected because they cover the range of wheel loads specified by bridge enginers for first-class highway bridges. The weight of the bridge slab consists of 29 lb. of steel and 28 lb. of concrete, or a total of 57 lb. per square foot. As stated at the beginning of this article, a 6-in. concrete floor properly reinforced will weigh 85 lb. and a wearing surface of asphalt laid on it will add another 30 lb., so that a total of 115 lb. per square foot of bridge roadway has to be allowed in the design of a bridge.



Deflection Contours Produced by a Total Load of 40,000 Lb. Contour Intervals $\frac{1}{100}$ Inch.



Deflection Contours Produced by a Total Load of 60,000 Lb. Contour Intervals $\frac{1}{100}$ Inch

FIG. 7—DEFLECTION CONTOURS ON TEST SLAB NO. 2

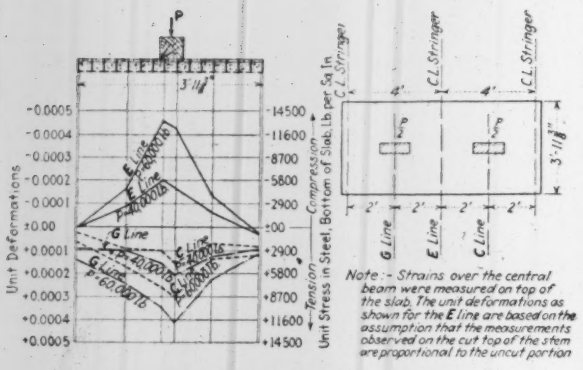


FIG. 8—STRESS-STRAIN RELATIONS ON TEST SLAB NO. 2

With the permission of the chief engineer of the New Jersey Highway Commission 500 sq.ft. of steel grating of similar surface armoring was laid in November, 1928, in the approach of the bridge over Crosswicks Creek near Trenton, N. J., on the highway between the Holland tunnel and Camden, N. J. Observations to date have shown no indications of wear or trouble.

It appears that a properly armored concrete surface of a bridge slab will require no additional pavement to resist wear and that the omission of this pavement will save the weight of another 30 lb. per square foot of roadway. The importance of the reduction in weight in the design of a long-span structure is self-evident. Using as a comparative example a roadway 40 ft. wide of 8-in. concrete and 4-in. granite, this would amount to a reduction in weight of 2,300 lb. per linear foot of bridge. What this means in any long-span bridge need not be further emphasized. The same advantage of reduced weight appears with great force where existing bridges, even of shorter span, have to be strengthened and no additional dead load can be put on them. The tests described herein were made for the Tri-Lock Company, of Pittsburgh, Pa.

Value of Mechanical Ventilation in Tunnel Driving

Examples of Ventilating Practices on Large and Small Tunnels of Various Lengths

THAT the practical and economic advantages of ventilating tunnel headings are sometimes overlooked was stated in a communication received recently, and this led to an inquiry as to practice and experience. The net result, as summarized below, is an indication of the value of ventilation in regard to increased progress, safety and economy of the work.—EDITOR.

ON LARGE JOBS of tunnel construction the value of ventilation as a means of safeguarding and expediting the work, as well as a measure of economy, is generally recognized and utilized. But on smaller jobs, particularly where the contractors, foremen and workmen are less exerienced in this special class of work, ventilation is apt to receive rather secondary consideration. Since working conditions are closely related to safety and progress in construction, a paper on the practical and economic importance of ventilation was prepared recently by S. Langner, industrial engineer for the U. S. Fidelity & Guarantee Company, Chicago, in order to press this relation home to contractors with whom this company is concerned. A brief abstract of this paper is given below:

Consider a 7-ft. sewer in rock 40 ft. below the surface, with headings about 300 ft. from the shaft and in opposite directions. After each blast it requires usually fifteen minutes of waiting before anyone can go into the tunnel to determine that all charges have been fired. It requires an additional 45 minutes before the smoke has cleared sufficiently for men to continue their work, and even after an hour of waiting the working conditions are by no means ideal. Vision is obstructed by the smoky atmosphere, while the insufficient supply of fresh air causes the employees to think and move slowly. The lack of oxygen may cause detrimental effects upon the human system, with the result that men may demand compensation payments or may quit their jobs.

Mining is similar to tunnel work in some cases, and the following statement is made in Bulletin 204 of the U. S. Department of the Interior, "Underground Ventilation at Butte": "A 30 per cent loss of efficiency due to defective mine ventilation among men working underground at Butte is probably a conservative estimate, but figured for 13,000 underground workers with a wage of $5.75 per shift, this loss amounts daily to $22,425, totaling $672,750 in 300 working days."

On a 7-ft. sewer tunnel with manholes 500 ft. apart, great savings might be effected by installing a ventilating system which would completely renew the air in a 300-ft. length in about ten minutes. The investment cost of $1,000 to $2,000 for a plant supplying about 1,000 cu.ft. of air per minute would soon be covered by the resulting savings. It is estimated that 30 men would be saved four hours of waiting every day, or 120 man-hours per day at 70c. an hour, amounting to $84 per day. This amount would be incidental when compared with the savings effected by the increase in efficiency resulting from the improved working conditions.

While the above abstract of Mr. Langner's paper may represent conditions prevailing in many cases, it omits mention of ventilation provided incidentally rather than by special apparatus. The exhaust from compressed-air drills aids ventilation, and if air-operated mucking machinery is used, the combined exhaust may provide sufficient ventilation. After an examination of the paper, therefore, inquiries were made as to the practice and opinions of several engineers experienced in tunnel work. From the replies received the following information is compiled.

Railroad Tunnels—In driving seventeen rock tunnels on one railroad, mostly for single track and with lengths ranging from 70 to 6,500 ft., a ventilating plant was installed for only the one longest tunnel, driven from both ends. In fact, it is considered that in tunneling with pneumatic tools, no ventilating equipment is required where the distance from heading face to portal or shaft does not exceed 1,000 ft. This is based on the assumption that all shots can be fired during change of shifts or at meal time, with little or no loss of time due to air conditions within the tunnel.

In a rock tunnel on another road, the air is allowed to blow through the drills after the blast has been fired, which is during the two-hour interval for changing shifts. From a third railroad the statement is made that while blasts are fired when shifts are changed, in order to take advantage of the time to allow the tunnel to clear, still there is no question as to the detrimental effects of gases from high explosives. On this account, it is stated, the relatively small expense for an adequate ventilating plant would be repaid to the contractor many times due to the increased efficiency of his forces.

Municipal and Power Tunnels—As to sewer tunnel construction, which is particularly mentioned by Mr. Langner, an engineer of large experience in this class of work states that mechanical or special ventilation is used frequently and that Mr. Langner's statements are

quite in accordance with the facts. Where the tunneling is not carried on continuously and where the section is relatively large, it is often practicable so to schedule the work that blasting can be done at the end of a shift, giving ample time for the heading to clear.

In some cases two headings in opposite directions from a shaft are driven alternately by one crew, the men working in one heading while the other is clearing by natural process. But where the driving is continuous at any one heading, there is sure to be delay after a blast unless some means of mechanical ventilation is provided.

For other municipal tunnel work it is pointed out that the distance of 500 ft. between shafts or manholes, as assumed by Mr. Langner, is a rather exceptionally favorable condition. On work in 8- to 16-ft. tunnels where this distance is 2,000 to 5,000 ft., or sometimes even 10,000 ft., each drift is supplied with about 5,000 cu.ft. of air through an 18-in. pipe whose discharge end is 200 to 300 ft. from the face. This is supplemented by the exhaust from the drills. During and after shooting, the fans are reversed to draw out the smoke and gas through the pipe.

On this work there are two shifts in 24 hours, the muckers working from 8 to 4 and the miners 12 to 8, day and night. The time is distributed as follows: The muckers go in at 8, and by 12 have enough muck removed to enable the miners to set up the drills, while all the muck is removed usually by 2 o'clock. The muckers are allowed to leave as soon as this is done, so that the working time is six to seven hours. By 3 or 4 o'clock the miners are ready for blasting. When the first shot is fired, the high-pressure air is turned on at the face, and in about twenty minutes the drift is cleared sufficiently to allow the miners to load for the second shot. Three shots are fired usually, but additional shots are required if there are missed holes. The shooting is completed usually by 6 or 7 and the miners leave as soon as the last shot is fired, which allows time for clearing the drift before the next shift enters.

With this system there are practically no complaints as to lack of ventilation. The fastest driving has been done by continuous mining and mucking in three shifts. But the two-shift method as described, giving practically continuous 24-hour operation without any gang being paid while waiting for smoke to clear away, is found best suited to the local conditions of labor, high wages and long drifts.

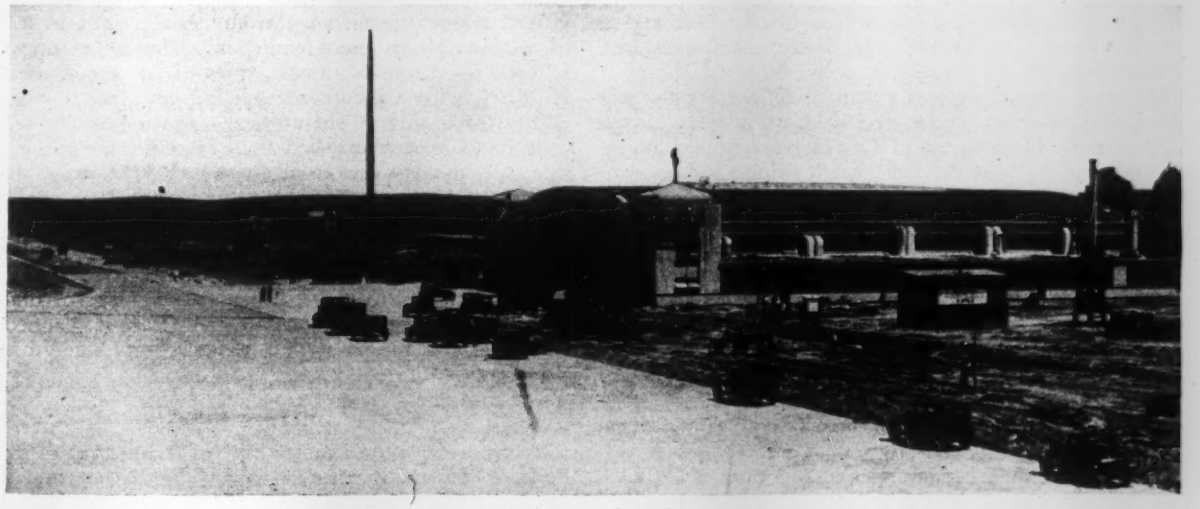
Finally there is a report as to driving a 15-ft. power tunnel 850 ft. long. Here a blower was installed at the portal and a ventilating pipe extended as near to the face as blasting would permit. Thus the men were able to return to the heading in five minutes after the shot and could start work inmmediately in practically fresh air. The engineer in this case states that such ventilation has been used on all tunnel work with which he has been connected during fifteen years and that little argument should be needed to convince construction men as to the importance and economy of good ventilation on such work. For any ordinary tunnel job he considers that the cost of ventilation is justified by the increased progress and safety. Furthermore, he states that contractors specializing in tunnel construction usually install ventilating apparatus, and while there is a certain class of labor that follows tunnel work, it would be difficult to hold a good crew of experienced tunnel men on a job where ventilation is not provided.

Progress on the Air-Rail Station at Columbus, Ohio

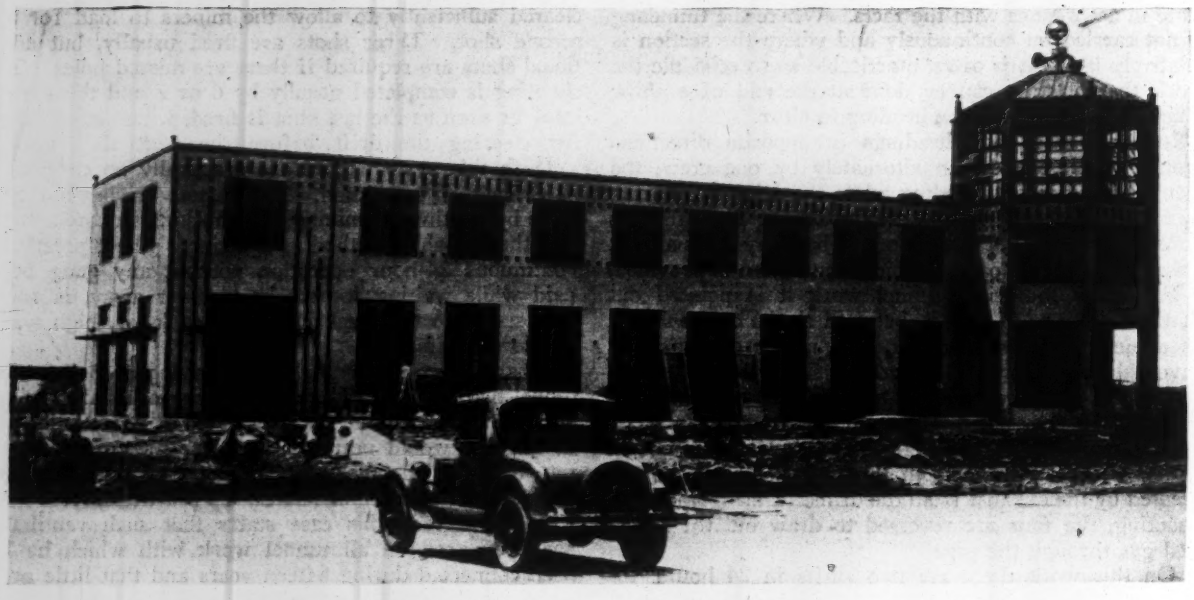
Depot and Hangars of Concrete and Brick—Concrete Runways With Asphalt Top—Drains of Vitrified Shale Tile

PORT COLUMBUS, the municipal airport at Columbus, Ohio, used by the Transcontinental Air Transport in its coast-to-coast air-mail service, is nearing completion. Three main building units are in service, runways, aprons and other paving are in, the lighting equipment is installed and much of the grading work is done. Construction work on several other hangars is now under way.

The depot or administration building is one of the most pretentious yet built. It is located close to the southern edge of the field adjacent to the tracks of the Pennsylvania and Baltimore & Ohio railroads. Along the tracks two concrete platforms 600 ft. long covered with steel train sheds have been built. Alighting from the train on



THE TAT HANGAR AT PORT COLUMBUS
Another similar structure is planned adjacent to this one.



ADMINISTRATION BUILDING AT THE COLUMBUS (OHIO) MUNICIPAL AIRPORT
Note railway station platform in left background.

these platforms, the passenger walks through a covered passageway into the administration building. A similar canopy extends from the administration building out to the cabin of the plane so that the passenger is protected at all times. The ultimate plan contemplates an underground tunnel from the train to the depot.

The administration building, as well as the hangars and all other structures on the field, is of concrete and brick construction. The administration building is 34x106 ft. in plan and is two stories high. At the northwest corner is an octagonal tower 20 ft. in diameter, the top of which is glass inclosed to provide a clear view of all parts of the field. This tower houses the airport weather bureau and the lighting control switchboard. The present administration building is but a portion of the final structure, and the first annex will be built at the western side so that the octagonal tower will be in the center of the structure on the field side.

On the first floor of the administration building there is a lounge room for women, a general passenger waiting room, a dining room, a kitchen, a ticket office and a baggage room, and on the outside an awning-covered terrace from which guests may view the field.

On the second floor is a group of offices for the use of companies operating at the field. There is also a room for the Department of Commerce representatives, who constantlty visit the field, a telegraph room, a man pilots' lounge and showers; also lounge, showers and dressing room for woman pilots.

Five hundred feet north of the administration building is the first of a series of nine planned hangars. It is one of the two that serves as operating headquarters for the Transcontinental Air Transport. This hangar is 167 ft. 3 in. wide and 206 ft. long. Door openings are 120x22 ft. maximum. A mezzanine floor running for about half the length of the structure provides storage space, and a series of rooms on one side gives additional space for other purposes.

Each of the nine hangar sites in this area is 225x360 ft., and restrictions as to size and type of hangar are enforced. Lots are leased by the city to operating companies for $1,000 a year. A municipal hangar 125x210 ft. and costing about $110,000 is under construction. The nine sites are all leased at the present time. There are twelve other and slightly larger sites on the north side of the field.

Two runways have been built. A prevailing-wind runway 3,500 ft. long and 100 ft. wide extends northeast-southwest. A 2,500-ft. runway of the same width runs at nearly right angles to this. It is claimed that the prevailing-wind strip can be used for landing and taking off approximately eight months of the year. Both runways are built with a 6-in. slope one way, no crown being used. Runways are connected by a 30-ft. paved taxi strip running the length of the hangar area, and a 120-ft. concrete apron in front of each lot increases the paved area in front of the hangars to 150 ft. Runways and taxi strips are 5-in. concrete slabs covered with 1½ in. of 5 per cent asphalt top.

An extensive drainage system has been installed, 5-in. tile drains being used with a minimum grade of 0.2 in. Numerous tests satisfied the city engineers that a tile of vitrified shale would withstand the airplane impacts. Outside of the runway area, rows of tile are spaced 60 ft. apart, with a minimum covering of 2 ft. On areas 200 ft. each side of the runways, spacing is 30 ft. A continuous inlet of crushed stone is placed along the low side of each runway. In all there is 163,000 ft. of drain tile in the field. A storm sewer 6,600 ft. long, starting at 15 in. diameter and increasing to 48 in., carries the water to a near-by creek. City water is delivered to the port. No sewerage extensions were made, but a complete disposal system, consisting of a number of underground treatment tanks, was installed. It is planned to cover the field proper with a turf of tough blue-grass.

Germany to Have Deep Canal

A canal accommodating ships of 1,300 tons is to be built to connect Bremen, Germany, with the Ruhr district. It will parallel an old channel only deep enough for 750-ton vessels.

Airport Competition Reveals Many Innovations

Tunnels Connecting Station With Plane Landing Points on Field, Separate Runways for Landing and Taking Off, Large Automobile Parking Spaces, Rail and Bus Connections, Recreational Facilities, Depressed Lights Along Runway Center Lines, Extensive Taxiway Areas Represent Some of the Features of the Prize-winning Designs in Contest Sponsored by Lehigh Portland Cement Company

THE WINNERS in the Lehigh airports competition, the first American contest for designs of modern airports, were selected recently by a jury composed of men eminent as engineers, architects and aircraft company officials. Prizes totaling $10,200 were awarded by the Lehigh Portland Cement Company, sponsor of the competition.

The first prize, $5,000, was awarded to A. C. Zimmerman and William H. Harrison, associated architects and engineers, of Los Angeles, Calif. The second prize, $2,500, went to C. Gifford Rich, architectural designer, Chicago, the third prize, $1,000, to Odd Nansen, East Orange, N. J., and Latham C. Squire of New York City, who prepared a joint design, and the fourth prize, $500, to Will Rice Amon, architect, New York City. Twelve honorable mentions, each carrying a $100 prize, also were awarded.

The Lehigh airports competition was inaugurated as a serious endeavor to contribute something of practical value to the field of airport design and with the hope that the designs submitted might serve as guides for the expenditure of the large sums of money which will be required within the next few years for the ground facilities of commercial aeronautics.

The competition program was formulated by a committee, which also appointed the jury of awards from among its members. The jury, which passed upon the 257 entries in the competition, was headed by Raymond Hood, architect. The aeronautics group included George W. Lewis, director of research, National Advisory Committee for Aeronautics; Casey Jones, president, Curtiss Flying Service, Inc.; and John W. Berry, manager, Cleveland municipal airport. In the engineering and city planning group were George B. Ford, airfield planner to the War Department; Willard Chevalier, publishing director, *Engineering News-Record*, and E. P. Goodrich, consulting engineer and airport adviser to the Chinese national government. The architectural group, in addition to Mr. Hood, included Prof. William A. Boring, dean, school of architecture, Columbia University, and Parker Morse Hooper, editor, *Architectural Forum*. Francis Keally, architect, was professional adviser to the jury of awards.

Each contestant submitted two wash drawings, one showing a plan and the other a perspective of his proposed airport. Each drawing included such sections and elevations of structures and details as the contestant desired to present. In this article are included brief statements by each of the first four prize-winning contestants. These statements set forth the features of the several airport layouts and analyze some of the reasons why the designers adopted the particular layouts submitted. Only such reproductions of drawings are given as are necessary for an understanding of the airport plans.

* * *

Quadrant Airport Featuring Maximum Utilization of Available Space Awarded First Prize

By A. C. Zimmerman
Architect and Engineer, Los Angeles, Calif.

FOR our field layout we chose the quadrant of a circle, and by placing this in a square secured the maximum concentration of buildings and other facilities. The quadrant was chosen of such size that eight runways could be utilized, making what is known as a sixteen-way field, in which the shortest runway is 3,500 ft. long. Since the contest program stipulated that the prevailing winds should be assumed equal in the eight cardinal and quarter points of the compass, we felt it mandatory that these runways form angles of 22½ deg. with each other. The eight-runway system was used so that it would be possible, regardless of wind direction, to have a plane landing on one runway and another plane taking off on another runway, with no interference and with no plane off wind more than 22½ deg.

If necessary, this sixteen-way field can be cut to an eight-way field (by dispensing with the two runways that are parallel to the sides of the field and with the two runways that are 45 deg. to the sides) without destroying the essentials of the design, although this would eliminate the possibility of simultaneous landings and take-offs. This arrangement also would necessitate replacing with a taxi strip the center runway that runs into the loading point. The taxi strips on the field, as it is laid out in Fig. 1, are used for field control and for rapid clearance of planes from the runways.

The entire design is built around the field control tower and loading point for transport planes. With the arrangement shown in Figs. 1 and 2, it is possible for five transport planes with 100-ft. wing spreads to taxi up to the loading point, simultaneously load or unload and taxi away under their own power without interfering with one another. Larger planes can be accommodated by extending the telescoping steel tunnels, shown in Fig. 2. These tunnels were devised to protect passengers from the weather at all times, to keep them away from revolving propellers and to control absolutely their access to the field itself. There are three such tunnels used for unloading and two for loading, but this division can easily be changed by shifting the partitions between the arriving and departing portions in the loading station. Future expansion at the loading point can be taken care of by building intermediate tunnels and lengthening the existing tunnels.

The first floor of the field control tower building is devoted exclusively to passenger facilities. An employees' circular stairway leads to the second floor, on which is a pilots' registration room, the radio department, weather bureau, toilets, lockers and a large room for pilots. The third floor is devoted to field control.

We felt the necessity for separating small private or

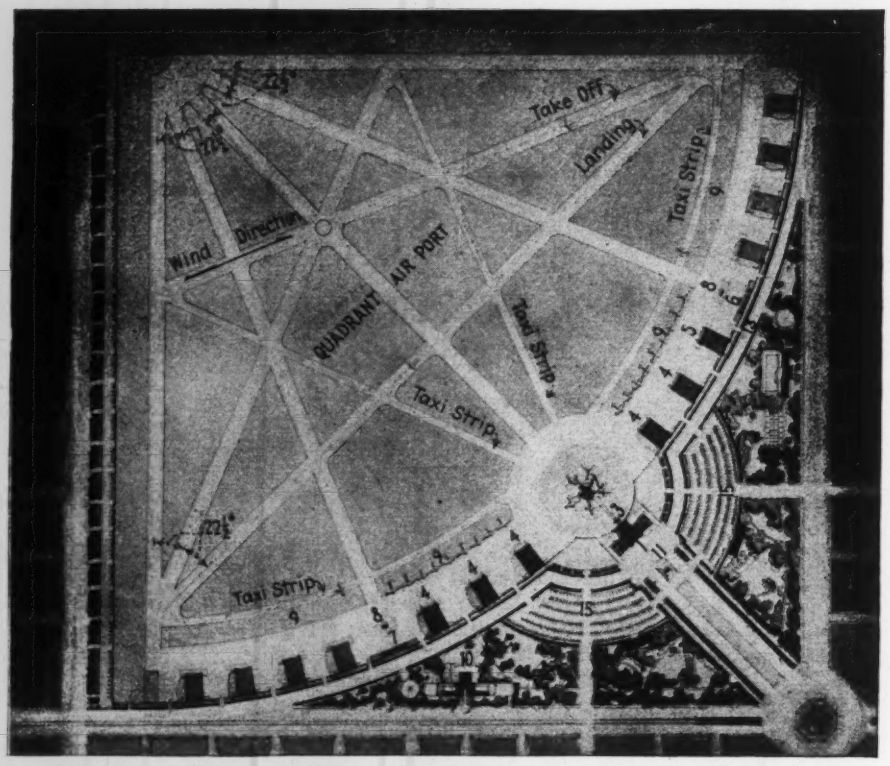


FIG. 1—PLAN OF THE FIRST PRIZE DESIGN

Special features are the quadrant shape of the flying field, and the star-shaped loading point and control tower with underground access for passengers from the main terminal building. The legend is as follows: (1) passenger terminal; (2) field control tower; (3) loading point for private taxi planes; (4) hangar and maintenance space; (5) repair space; (6) fire apparatus, ambulances, test block; (7) maintenance equipment; (8) filling station; (10) hotel; (11) beacon; (13) railroad spur; (15) parking space for automobiles.

taxi planes from the large transport planes, and as a consequence provided facilities for these small planes at the end of the observation terrace, as shown in Fig. 2.

The transort planes are reached by going down a ramp leading out of the passenger station, through a tunnel, and up a ramp into the loading point building. Deplaning immigrants must ascend a stairway from this tunnel and go through the immigration department before entering the passenger station proper.

We are gratified to know that the jury commended the design for the logical development of facilities for the comfort and convenience of passengers and fliers. As may be seen by Fig. 1, passengers reach the airport through a broad plaza at the junction of two important boulevards, where provision also has been made for the underground approach of a subway or a railway. The approach plaza is developed as a park and is provided with large automobile parking spaces, arranged in a semicircle about the passenger terminal. This terminal building has a waiting room very similar to that of a railroad station, with ticket and information booths, baggage rooms, a large restaurant and lunch counter, news-stands and similar facilities. Provision has been made for mail, express and freight handling, with offices for immigration, customs and public health officials. The entire second floor of the passenger station is used for observation purposes. Ample provision is made for future expansion in this building. The design of all of the buildings of the airport is modern in character and they are designed as being principally of concrete, the finish and the ornament being cast in place.

The hangars, service shops, fire station and other field facilities are grouped along the semicircular edge of the field. For the benefit of visitors, a small hotel, playground, swimming pool, stores, shops, etc., have been suggested and provided for should they subsequently prove to be desirable. Care was taken to make the entire airport attractive from the air as well as from the ground.

Obviously, this prize-winning design is our solution of mandatory requirements of the competition program. Therefore, it is not held up by its originators to be an ideal or standardized layout for all airports. Each airport is an individual problem. However, it is quite possible that in our design and in that of many of the other competitors are many good features that would be applicable to any airport.

Runways Radiate From Central Control Building in Second Prize Design

By C. Gifford Rich
Of Charles Wheeler Nichol, Inc., Architects
Chicago, Ill.

IN PLANNING the modern airport, the fact should be borne in mind that the present design of the airplane and its ultimate development as to size, shape and operation is most important. That is, the airport should be designed about the airplane in the same manner that we plan our garage for the automobile and our dock for the steamship. Various shapes of landing areas are being used, including the L-shaped field, the triangular-shaped field, the "Union Jack" type and the rectangular field. The rectangular or square flying field is, perhaps, the most common at the present time, and it was chosen

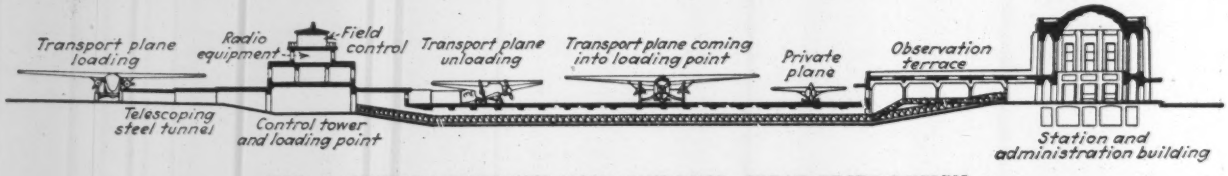


FIG. 2—SECTION THROUGH MAIN BUILDING—FIRST PRIZE DESIGN

Underground connection between station and loading point. Also telescoping steel tunnels at loading point which may be extended for planes with longer wings. Another feature is the separation of private and transport plane facilities.

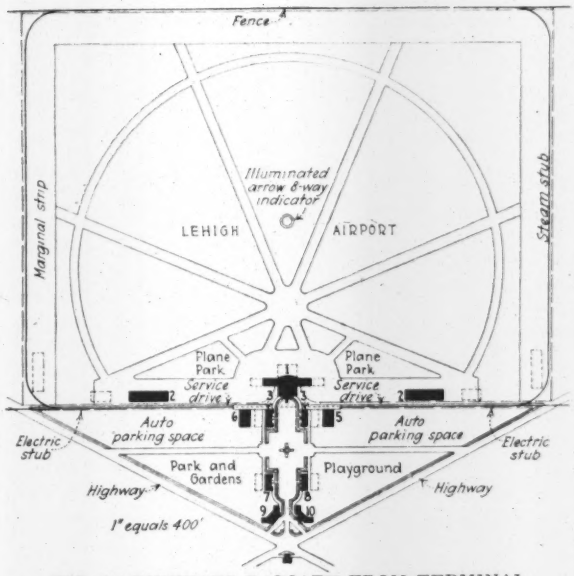


FIG. 3—RUNWAYS RADIATE FROM TERMINAL BUILDING IN SECOND PRIZE DESIGN

One of the features of this design is the use of depressed lights along the centerline of the runways. Circular taxi strip provides access to far ends of the runways without interfering with field activities. Key to buildings is as follows: (1) administration building; (2) hangars; (3) garage with display window; (5) boiler, pump, power and fire station; (6) maintenance equipment and freight; (7) private garage with display window; (8) recreation building; (9) public hotel and bus stop; (10) officials' and pilots' apartments.

for my design as being best for developing an eight-way drome, which is ideal for flying in all wind directions. Also, the rectangular field with runways radiating from a central control building cuts the taxi-ing distance with full load to a minimum, thus saving time and providing the utmost ease of control for dispatching planes. It will be noted in Fig. 3 that the main passenger terminal is located on the central axis of the landing area. This being the control building for all activities on and about the airport, the problem resolved itself into the proper approach to this building and the efficient distribution of the other necessary structures.

In planning the fore-court or plaza, the opportunity which we have long desired presents itself—that is, to develop a beautiful plan which we will be able to see and appreciate. This opportunity should not be overlooked, for it is one of the things that attract the public, and at the present time the air-mindedness of the people is the one great achievement for which we are striving.

The main passenger terminal, of modernistic design, is provided with overhead wings under which arriving and departing planes may stop,

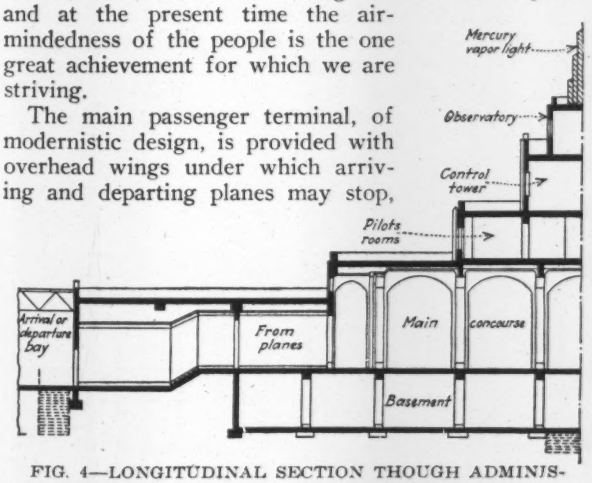


FIG. 4—LONGITUDINAL SECTION THOUGH ADMINISTRATION BUILDING—SECOND PRIZE DESIGN

and where passengers are protected during inclement weather. The field itself is equipped with four landing strips crossing one another near the terminal building and connected near the ends by a narrow circular taxi strip, permitting planes access to either end of the runways without interfering with planes on the field.

The problem of providing sleeping accommodations for the personnel and hotel facilities for guests is unlike the problem of the railroad hotel. The continuous roar of arriving and departing planes necessitates a departure from the combination station and hotel used on the railroads. Here again the future development of the airplane may alter designs, but at the present time it is evident that the hotel should be located as far as possible from all flying activities and at the same time function as a unit of the general layout.

The outstanding features of my design are the expeditious handing of freight and mail, the comforts and conveniences for passengers, the practical and economical accommodations for servicing planes and the ease and economy for expansion not only of the main terminal building but of each unit in the layout.

Height of Terminal Building Reduced by Placing First Floor Underground in Third Prize Design

By Odd Nansen
Architect, East Orange, N. J.

IN THE design of a modern airport the final result should be a fusion of ideas contributed by aviation experts, city planners, engineers and architects. Latham C. Squire and myself, in submitting our joint design, assumed the requirements prescribed by the competition as the conventional needs. In determining this design, the principal thought was to create a comprehensive plan, with all buildings so located as to render the greatest efficiency, safety and practicability as well as architectural beauty. Thus a certain informal, though logical, plan resulted.

I consider the height and location of the terminal building to be of utmost importance. It is, in fact, the vital problem in the design of any airport at the present time. We have placed this unit, with its arrival and departure bays, as close to the field as practical aviation permits, in order to secure immediate take-off or landing without tortuous detours. The ground floor of the terminal is placed one story below the level of the field. Thus all passenger traffic is kept clear of the field, and the height of the terminal building, above the field level, is reduced one complete story over what would otherwise be unavoidable.

Bearing in mind that planes must be brought to and from the hangars without causing interference with flying or other traffic activities, the hangars are placed a suitable distance from the terminal building on the side of the highway approach and along the edge of an unbroken concrete apron entirely surrounding the terminal building. This provides ample space for taxi-ing planes between the arrival and departure bays, hangars and runways, and also serves as a means of direct access to the railroad freighthouse, shops, storage and other necessary buildings, which form balancing groups at the extreme property lines on each side of the terminal building.

All passenger traffic to and from the terminal is directed through an underground concourse starting at

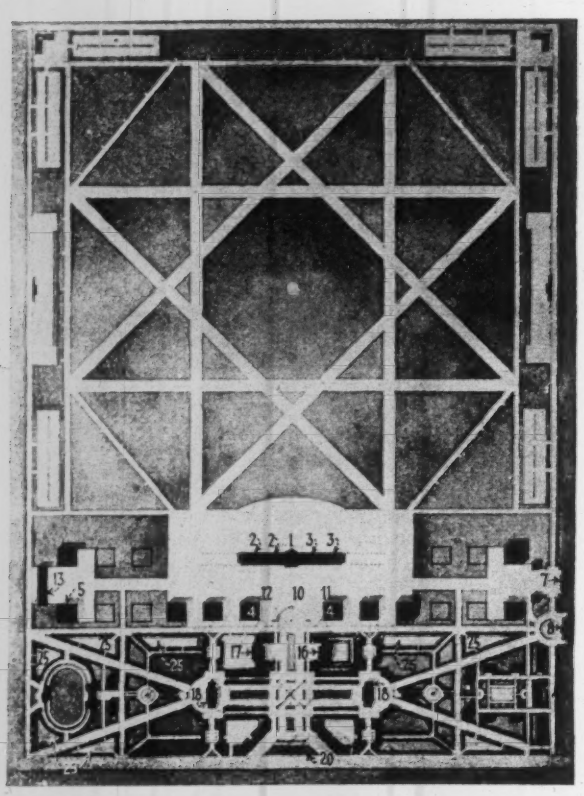


FIG. 5—DEVELOPMENT OF RECTANGULAR AREA FEATURES THIRD PRIZE DESIGN

Approach to the terminal is underground from the entrance plaza, while loading and unloading points for planes are at the field level. Key to buildings: (1) passenger terminal; (2) arrival bays; (3) departure bays; (4) hangars; (5) leased hangars for storage; (8) railroad passenger station; (10) underground tunnel approach for passengers; (11) outgoing freight tunnel; (12) incoming freight tunnel; (16) hotel; (17) bus terminal; (18) exhibition building and pavillion; (20) radio station and tower; (25) auto parking.

the end of the main approach from the highway and leading directly into the main waiting hall below the field level. Although the terminal building is of minimum height, the architectural treatment of the entrance to the underground passage with stores along the edge of a half-circle plaza, created in front of it, will give the building the effect of additional height, looking at it from the main approach. Thus this principal unit, with its long wings of horizontal architecture broken by a central feature of vertical lines crowned by the dome over the waiting room, will dominate the entire scheme and create a natural and logical center of gravity, from an architectural point of view.

The remainder of the plan is largely self-explanatory by referring to Figs. 5 and 6. The fact that aviation today does not enjoy the confidence of the general public to the extent to which it is entitled is due principally to the fact that most of the present airports do not create in the mind of the individual a sense of confidence and dignity, but rather one of insecurity and skepticism. Realizing this, we have endeavored to present a definite building and landscaping program to be used as a guide in the growth of the ideal airport in the future.

Continuous and Uninterrupted Flow of Traffic Sought in Fourth Prize Design by Use of Circular Field

By Will Rice Amon
Architect, New York City

THE first problem considered was the flying field proper. No special shape being designated, the circular field was chosen as giving the maximum flexibility and adaptability to the changing needs of flying. The double system of runways (Fig. 7) provides a continuous flow of traffic with no confusion in landing and taking off. It is possible to build one set of runways and add the parallel set later as traffic demands. If a considerable amount of traffic is expected, the double system is obviously a necessity.

The next consideration was the terminal building and its relation to the field. Here again an uninterrupted and definitely directed flow of traffic is desirable. The arrangement adopted relates the various units, so that a plane on landing at the field taxis to the arrival shed of the terminal, deposits passengers and baggage and passes on to the gas pits, departure shed or hangars. Outgoing planes leave the hangars, pass the gas pits, take passengers and baggage at the departure shed and taxi to the field by a different lane from that used by incoming planes. This circulation is arranged with no sharp turns.

All traffic is directed from the control room at the top of the terminal building overlooking the field. Directly beneath and connected to this room are the radio

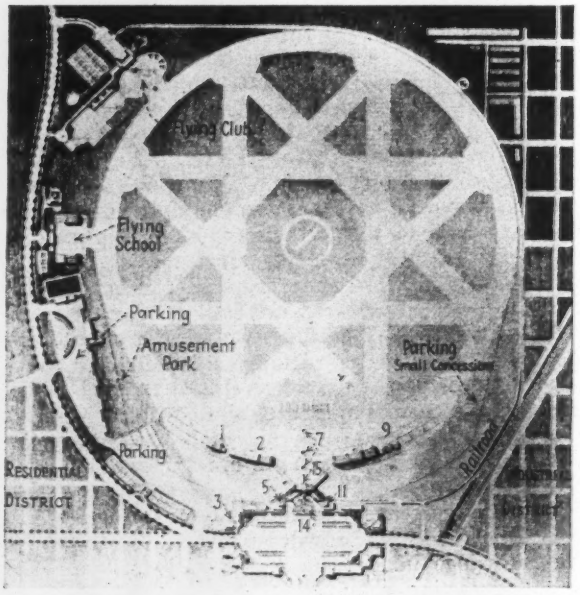


FIG. 7—FOURTH PRIZE DESIGN UTILIZES A CIRCULAR FIELD WITH PARALLEL RUNWAYS

Note that the border of the field is paved as a taxi strip and that flying school and flying club facilities are separated from transport activities. Legend is as follows: (1) repair shop; (2) hangars; (3) hotel; (5) bus terminal; (7) gasoline pits; (9) fire and ambulance station, (14) beacon; (15) main terminal.

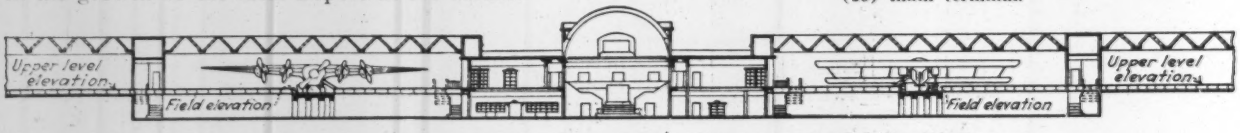


FIG. 6—LONGITUDINAL SECTION OF TERMINAL BUILDING THIRD PRIZE DESIGN

First floor of terminal building placed below ground in order to reduce height of the structure above the field.

and meteorological rooms. Passengers entering the terminal concourse have the information and the ticket counters at their right, with the baggage room directly ahead and the passage to the departure shed also at their right. On the mezzanine over the baggage room and out of the direct line of traffic is the waiting room, with the restaurant at one side and the rest room at the other, all with a view of the field. Incoming passengers pass custom and immigration offices on their way to the concourse. The arrival and departure sheds afford protection for passengers and planes. A tunnel allows the passengers to go to the planes underground.

The secondary buildings, which include the hotel, bus station, shops, freight station with railroad connection and a building for the exhibition and sale of planes, are connected with the terminal by a covered arcade. The freight station is connected to the baggage platform in the basement of the terminal by means of a tunnel.

The marginal areas are used for a variety of purposes, including a flying school, a flying club, a tennis club, a recreation center with swimming pool and areas for the development of industries related to aviation. Areas for public parking and observation are included, and portions of these can be utilized for future extension of the field.

The entrances to the flying field at the school and club are guarded by control booths that permit the planes to enter the field only when signaled from the central control. These planes join the general circulation of the field, but do not loop into the terminal. This provides complete separation of private, student and commercial flying, except on the field, where the planes are under the direction of the central control office.

The end sought in this design was a definitely directed and unconfused circulation of planes and passengers. The scheme provides for 100 per cent increase of facilities without destroying any of the existing structures.

Letters to the Editor

The Old Seventh Street Bridge at Pittsburgh

Sir—In your account of Dec. 26, 1929, of the three new bridges over the Allegheny River at Pittsburgh, which replaced at a higher level three old toll bridges, you mention that the old Seventh Street bridge was a suspension bridge of the usual type.

From the inclosed photograph it will be noticed that the braced double-chain bridge, designed and built by me in 1884, was not of the usual type but that, on the contrary, there was not in this country, nor is there now, another bridge of that suspended braced-chain arch type. That it had claim to architectural distinction can hardly be denied.

A bridge similar in appearance (but single-chain, with suspended arch stiffening) is the Grand Avenue suspension bridge in St. Louis, built four years later by Carl Gayler.

There formerly were in Vienna two bridges of the braced double-chain type, crossing the Danube Canal. These were built over 60 years ago, but were replaced with heavier and wider arch bridges about twenty years ago.

Jersey City, N. J., Dec. 30, 1929. GUSTAV LINDENTHAL, Consulting Engineer.

Our quoted statement was an obvious error; the statement concerning the Seventh Street bridge should have read that it was "a suspension bridge of *unusual* type." Further, as Mr. Lindenthal justly but somewhat modestly points out, it had architectural distinction. It was in fact a structure of striking character in esthetic regard; for, built in a period of utmost plainness and conventionality of design, it was marked by originality and beauty in equal degree.

A statement which may have appeared in our pages on earlier occasions warrants repeating on the present occasion: that for many decades Pittsburgh has been the home of a larger and more interesting variety of bridges than can be found any where else in this country, perhaps in the world. The group built in recent years by the city and the county well maintains this old tradition. The Jacks Run concrete arch; Sixteenth and Fortieth Street arch bridges, the suspension bridges at Sixth, Seventh and Ninth Streets, and the Manchester truss bridge, on the Allegheny River; the new Point bridge and the Liberty bridge across the Monongahela; and the West End and McKees Rocks bridges, soon to be built spanning the Ohio River, all constitute structural achievements of note. Structures such as the Beaver bridge of the Pittsburgh & Lake Erie Railroad, the Wabash cantilever, and the Ohio Connecting Railroad bridge, similarly claim a place of distinction in the records of bridge engineering. Among the men who contributed to this result were some of the most prominent ones of the art: John A. Roebling, Theodore Cooper, Albert Lucius, Paul L. Wolfal, and Mr. Lindenthal himself played a part in the work.—EDITOR.

SEVENTH STREET BRIDGE AT PITTSBURGH

News of the Week

Toronto Defeats Bond Issue for City Improvements

By a vote of 27,277 for and 29,680 against the citizens of Toronto, Ont., defeated a proposal to issue bonds to the amount of $19,000,000 which were to have financed a proposed scheme of improvement in the central business district of the city involving the opening of several new highways, the widening of existing streets and the acquisition of land for highway and park purposes. The total cost of the proposed improvements was estimated at $35,750,000, against which the authorities estimated an amount of $22,750,000 would be available from resale of land acquired, rental received therefrom prior to sale and bank interest on funds deposited. The bond issue of $13,000,000 was to have been used as a rotary fund to finance the work over a fifteen-year period. Opponents of the bond issue contended that the city should not be committed to such an extensive program affecting a limited area, but that improvements to the city as a whole should be worked out in accordance with a comprehensive plan.

Interest Payments on Moffat Tunnel Bonds Suspended

By an order issued late in December by the Colorado Supreme Court, the Moffat Tunnel Commission is restrained from disbursing taxes collected in the Moffat Tunnel Improvement District, which includes the city of Denver. This money was to be used to pay interest on the so-called $8,750,000 supplemental bonds issued by the commission in excess of the $6,720,000 in bonds provided for by the legislative act creating the Moffat tunnel project. The validity of these supplemental bonds is being attacked in a case now pending before the court.

Street Railway Fare Increase Allowed in Baltimore

In a decision handed down Jan. 6 the U. S. Supreme Court ruled that the United Railways & Electric Company, of Baltimore, Md., is entitled to charge a flat rate of 10c. on the street railways of that city instead of the rate of 10c. cash and four tokens for 35c. prescribed by the Maryland Public Service Commission. The court ruled that a return to the railway of 7.44 per cent profit on the present value of its property was not excessive and that to charge a fare netting less than that amount would be confiscatory. The Maryland Public Service Commission held that a return of 6.26 per cent, yielded by the present rate, was adequate.

Justices Brandeis, Holmes and Stone of the Supreme Court dissented from the opinion, taking the view that the franchise of the company, valued at $5,000,000, should be eliminated from the rate base, which would yield the company 7.78 per cent with the present fare charge instead of 6.26 per cent shown by the company's computations.

War Department Reduces Chicago Diversion

Upon the expiration Dec. 31 of the War Department permit under which Chicago has been diverting from Lake Michigan an average of 8,500 cu.ft. per second of water, the Secretary of War approved a renewal for a period of six months with a reduction in amount to 7,250 cu.ft. per second, with the provision that the permit should cease to control on the effective date of the expected decree of the U. S. Supreme Court, which now has the matter under consideration. It is further specified that after July 1, 1930, diversion will be limited to an average of 6,500 cu.ft. per second in addition to domestic pumpage.

An order issued by the Supreme Court Jan. 6 allows those involved in the case until Feb. 3 to file exceptions to the report recently submitted by Special Master Hughes. Should any exceptions to the report be filed, the clerk of the court is instructed to set such exceptions down for oral argument at the head of the calendar on Feb. 24.

Airport Study Planned

In line with the resolution adopted at the October meeting of the administrative board of the American Engineering Council, A. W. Berresford, the president, is organizing a committee of five members to consult with the aeronautics branch of the Commerce Department on working out a plan whereby the two organizations may co-operate in a study of the engineering problems involved in airport design and construction. This plan of action was recommended by a special committee of the council, headed by O. H. Koch, Dallas civil engineer and vice-president of the council.

Consideration previously had been given to the project by the council's committee on research work. H. E. Howe, chairman of that committee, reported that a study relating to the coverage and drainage of airports was one the council could properly undertake.

Power Plant Held Responsible for Raising Dam

That a power company is not justified in damaging existing upstream plants by raising the height of a dam, despite the fact that the action was approved by the Federal Power Commission, was held in a decision handed down Jan. 6 by the U. S. Supreme Court in a case involving the use of power at the federal dam located near the confluence of the Hudson River with the Mohawk at Troy, N. Y. The defendants, Henry Ford & Son, were incorporated under the New York State law to operate a power plant at the federal dam under lease from the federal government, and were authorized by the Federal Power Commission to place flashboards on the dam, raising the water level about 2 ft. The complainants, the Little Falls Fibre Company, the Asbestos Spinning & Weaving Corporation and Harry A. Furman, contended that the new level resulted in raising the water at the tailraces of their plants and reduced the power developed at their dam, about 3 miles above the federal dam. The court ruled that the complainants had a vested right to power which the Ford company was bound to recognize and protect under its license. Accordingly, it was held that the complainants were entitled to an injunction and to damages.

Engineering Foundation Succeeds United Engineering Society

With the approval of the four founder societies, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, the Engineering Foundation, Inc., has become successor to the United Engineering Society, eliminating confusion which had been caused by the fact that the old organization was not a society in the usual conception of the word, but was a corporation administering real estate, funds and a library for scientific, educational and other purposes. The change took effect Jan. 1.

The corporate powers and privileges of the foundation are vested in and exercised by a board of twelve trustees, three from each founder society. The foundation has three departments: the Engineering Societies Research Board, the Engineering Societies Library Board and the Administrative Department. It is titular owner of the Engineering Societies Building in New York City and the trust funds for the library and the research board.

The Engineering Societies Research Board, formerly known as the Engineering Foundation, was established in 1914. It was conceived by Ambrose Swasey,

who made three gifts totaling $500,000 to be the nucleus of a community trust fund for engineers, to be contributed to by many donors. The endowment fund now totals about $620,000. The board co-operates with the four founder societies, the National Research Council, technical bureaus of the government, universities, scientific associations and individual engineers in the field of engineering research.

The Engineering Societies Library is a free public library containing 125,000 books and pamphlets and 6.000 maps. It maintains a staff of technically trained searchers and translators, as well as reference assistants, and serves thousands of engineers in the United States and many foreign countries.

The Administrative Department manages the Engineering Societies Building and all trust funds. These include the Engineering Foundation fund, the Library Endowment fund, the Henry R. Towne Engineering fund, the Edward Dean Adams fund, the John Fritz Medal fund and a depreciation and renewal fund for the Engineering Societies Building.

New York Firm Offers to Finance and Build Arizona Highways

Merritt-Chapman & Scott Corporation, of New York, has made a proposal to the State Highway Commission of Arizona to finance and construct 1,000 miles of hard-surfaced highways within the limits of the state at a cost not to exceed $30,000,000 exclusive of interest charges. The proposal stipulates that the work shall be done in not less than four years nor more than seven, at the wishes of the state highway department. A schedule of expected revenue to the state from regular sources provided by law, such as gasoline tax, license and operator fees, one mill general assessment, etc., estimates that the entire cost of the roads would be paid for in fifteen years. The contemplated construction would be under the supervision of the state highway department. Estimates of the various projects would be prepared by the highway department, which, when agreed to by the contractor, would form the basis of compensation. The contractor would get 10 per cent of the estimate as a fixed fee, guaranteeing that the maximum cost would not exceed the estimate plus the fee. If the work is done below estimated cost, the fee would be based on the estimate, but the total cost to the state would be only the actual cost of construction plus the fixed fee. Payment would be acceptable in cash or in interest-bearing state warrants. Provision is made for the state carrying on highway construction independently of that designated by the contract by reserving a definite amount of state highway funds for this purpose.

The proposal has been referred to the Arizona Good Roads Association for consideration. This association is statewide and non-political, and has taken an active part in the past in state highway programs and their financing.

Reclamation Engineers Discuss Irrigation and Land Drainage

More Progress Needed—U. S. Supplies Water to Federal and Private Lands—Moratorium Plan for Drainage Taxes

ECONOMIC aspects of drainage and irrigation were prominent at the recent meeting of the land reclamation division of the American Society of Agricultural Engineers at Kansas City, Mo. The present work and program of reclamation under federal authority were supported strongly by Ellwood Mead, U. S. Commissioner of Reclamation, in view of some objections to this function of the national government. Reclamation of arid lands by private enterprise has practically ceased, owing to the high cost of providing water ($100 to $200 an acre), but there is greater need for and value in the work which the government is doing. Since its projects have a cultivated area of only 0.3 per cent of the total cultivated area of the country, their crops cannot affect general prices for farm products, but the projects have created new communities and have built up a co-ordinated public and private development in the use of river waters that formerly ran to waste. As a matter of fact the work now being done is too small in comparison with the needs of the western section of the country, but funds are limited and are now being spent on a ten-year program for completing projects already begun.

The government policy in supplying water to private irrigation enterprises by making its reservoirs large enough for this supplemental supply was dealt with by Hugh A. Brown, U. S. director of reclamation economics. At present the government has 77 contracts with a total value of $7,514,520. As a rule the private concerns pay for the water, but in the case of the American Falls project, in Idaho, these concerns advanced $3,378,000 toward the cost in order that the reservoir might be made of sufficient capacity to supply them as well as the government projects.

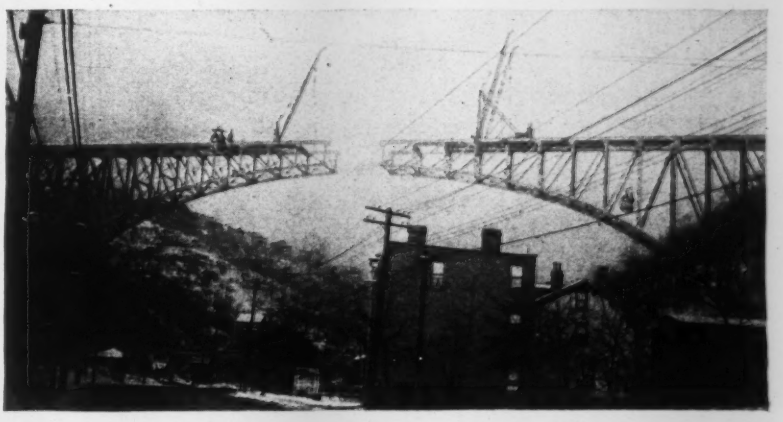
Moratorium Is Advocated

A moratorium period for taxpayers on drainage and levee districts, in view of the acute financial condition, was advocated by Clark E. Jacoby, consulting engineer, Kansas City, Mo., in a paper which was read in his absence. Principal factors in this condition are the excessive floods and the high cost of financing and construction during and after the World War. Minor factors may be large ownership of lands, inferiority of land reclaimed, inefficient and insufficient tenancy, low wages, overproduction of crops and deflation of land values. According to E. V. Willard, Minnesota commissioner of waters and drainage, his state is preparing to take over tax-delinquent lands under recent legislation which authorizes the acquisition of such lands for forest and game preserves. Terracing farm lands in the corn-belt states was discussed by Claude K. Shedd, University of Missouri, who stated that enough is known to warrant recommending this system. He considered that its success depends largely upon the farmer having equipment that will handle construction and maintenance efficiently.

Sedimentation in streams was discussed by Roy N. Towl, consulting engineer, Omaha, Neb., who reviewed the conditions of numerous home and foreign rivers. He favored cutoffs at bends, straight flood channels and overflow basins with reclamation of new flood plains.

Tile and ditch drainage of irrigated

PITTSBURGH CANTILEVER BRIDGE CLOSED



With a deck 220 ft. above the street below, the new $900,000 East Street cantilever bridge across a ravine in Pittsburgh, Pa., was closed Dec. 28. The structure consists of two side spans each 190 ft. 9 in. in length and a center span of 163 ft. 6 in. Trusses are 22 ft. 6 in. center to center. The suspended span is 19½ ft. deep at the center and 96 ft. deep over the piers. Work on the structure was begun last spring under the direction of John D. Stevenson, superintendent of the Pittsburgh bureau of bridges and structures.

lands to prevent waterlogging has proved inadequate in several places, according to E. H. Neal, Idaho Agricultural Experiment Station, who suggested pumping from wells to remove the excess water and utilizing this for further irrigation, since the original supply is limited. He estimated that in areas along the Boise River some 150,000 to 200,000 acre-ft. annually could be obtained by wells and pumping.

Use of Sewage for Boiler Feed Studied at Los Angeles

Because of the limited water supply in the Los Angeles territory, aggravated by several years of subnormal rainfall, studies have been started to determine the possibility of reclaiming the sewage water from the Los Angeles main outfall sewer for use as boiler-feed water in the El Segundo refinery of the Standard Oil Company. This plant is located at the ocean shore near the sewer outfall, and the present water supply from wells is seriously depleted on account of the general lowering of the groundwater level. Arrangements have been effected with the city of Los Angeles for the use of the sewage over a period of years, and plans are being prepared for a plant to make the water available for industrial purposes.

The city of Los Angeles is also studying this general problem. To carry on further experiments dealing with the possibility of using reclaimed sewage water for industrial and agricultural use, the Board of Water and Power Commissioners of Los Angeles on Dec. 17 appropriated $10,000 to establish a small-sized treatment plant and laboratory. The proposed experimental project was outlined by H. A. Van Norman, chief engineer of the water bureau, and included the employment of a sanitary engineer in connection with the work. Laboratory work on this problem has been in progress for several years by the water bureau and the results have justified the construction of the proposed experimental plant.

The Business Outlook

There is no marked change in any of the business indicators for the final weeks of the year, normally the low points in basic industrial activity and primary distribution. In both respects the 1929 levels were below those of 1928, but not more so than in preceding weeks. Building projects particularly appear to hold up well. The next two weeks' records will show whether the usual upturn in railway traffic will be as strong and the first of the year money turnover as large as a year ago. General trade sentiment does not indicate that the course of business will diverge greatly from the normal trend for the season.

—*The Business Week*, Jan. 8.

CONKLINGVILLE DAM NEARING COMPLETION

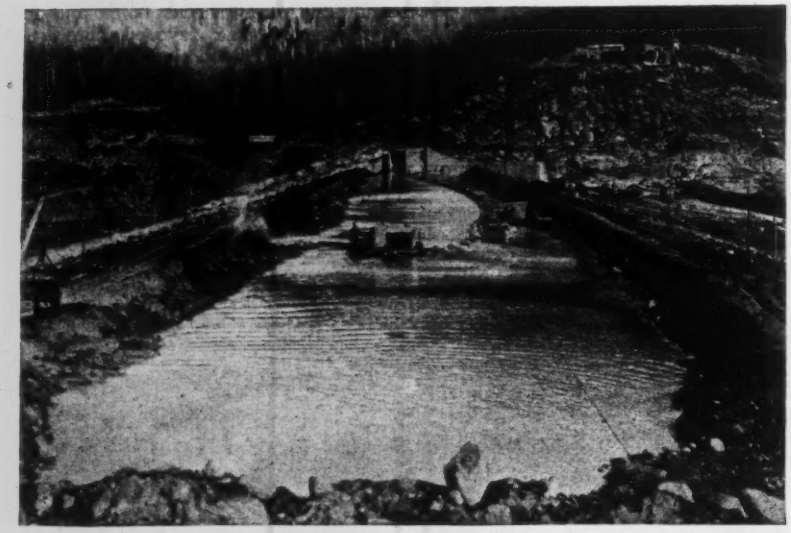


Illustration shows hydraulic sluicing on the Conklingville dam, being built on the Sacandaga River by the Board of Hudson River Regulating District. Hydraulic sluicing is now completed and the dam is being topped off with a dry-rolled fill. The concrete spillway structure is about finished, and work on the power house is well along. It is expected that the entire project will be completed within three months. The dam contains 670,000 cu.yd. of earthfill and 120,000 cu.yd. of rockfill and is 1,100 ft. long. The reservoir, 27 miles long and covering 42.3 square miles, will have a capacity of 30 billion cubic feet. S. J. Groves & Sons, Minneapolis, are building the dam under the supervision of Edward H. Sargent, chief engineer, and Albert S. Crane, consulting engineer of the regulating district.

Brief News

CONDEMNATION PROCEEDINGS are to be instituted to obtain flowage rights in the New Madrid floodway of the Mississippi River flood-control project, located on the west bank of the river in Mississippi and New Madrid counties, Mo. There are 639 tracts of land, containing 126,097 acres, involved.

ALL BIDS for the construction of a $500,000 turning basin and car-ferry slip on the east side of the Hudson River near Albany, N. Y., have been returned by the Albany Port District Commission because of failure to secure rights-of-way for highway and rail approaches to the site of the project.

AMERICAN STANDARDS ASSOCIATION has become a member body of the International Standards Association, according to announcement made recently by William J. Serrill, president of the American Association. Both Mr. Serrill and Cloyd M. Chapman have been re-elected to office for the year 1930, the latter as vice-president.

DEEPENING OF THE DELAWARE RIVER between Philadelphia and Trenton to provide a 20-ft. channel has been authorized by the War Department. The city of Trenton is to contribute $450,000 and is also to provide terminal facilities and areas for the disposal of dredged material.

CONTINUING PREPARATIONS for developing its water system, the city of Everett, Wash., has applied to the state division of hydraulics for authority to construct a $1,000,000 reservoir on the Sultan River. The reservoir would store 60,000 acre-ft. of water, with 2,000 acres of land submerged to a maximum depth of 175 ft.

SALARIES OF OFFICIALS in New York City have been raised by vote of the the municipal legislative bodies. Effective Jan. 1 the pay of the mayor was raised from $25,000 to $40,000; of the comptroller from $25,000 to $35,000; of the president of the board of aldermen from $15,000 to $25,000, and of the five borough presidents from $15,000 to $25,000.

ERECTION OF OIL TANKS and a wharf just north of the Francis Scott Key memorial bridge at Washington, D. C., has been disapproved by the National Commission of Fine Arts and the National Capital Park and Planning Commission on the ground that these would interfere with the scenic beauty of the Virginia side of the Potomac River and hamper plans for construction of a drive along the river to Great Falls, Va.

THE BOARD OF WATER AND POWER COMMISSIONERS of the city of Los Angeles passed a resolution Dec. 24 urging the acquisition by the city of the entire electric system of the Los Angeles Gas & Electric Corporation. The resolution incorporated the provision that the purchase should be made at a fair valuation to be deter-

mined "by mutual agreement, if practicable, or by the California Railroad Commission." The corporation has announced that it will not sell.

REPAIRS TO THE WHITE HOUSE executive offices, damaged by fire Dec. 24, will be made by the Charles H. Tompkins Company, of Washington, D. C. The work, which includes fireproofing above the first floor ceiling, will be done within 90 days at a cost of $74,880.

WASHINGTON NOTES

BY PAUL WOOTON
Washington Correspondent

Toll Bridge Recapture — Flood Control by Reservoirs — More Funds for Rivers and Harbors

BELIEVING that present laws favor investors at the expense of the general public, Representative Denison, of Illinois, has introduced a bill revising the federal policy with respect to toll bridges and their recapture. This bill provides that, in assessing the value of a privately owned bridge over a navigable stream for the purpose of recapture, prospective profits, franchise rights and any prior sales price shall be disregarded and the price shall be determined solely by the actual investment in the bridge at the time as determined by prescribed methods.

Delay Flood-Control Hearings

No hearings will be undertaken by the flood-control committee of the House of Representatives until after the receipt of the report of the Chief of Engineers covering the review of the plan made at the request of President Hoover. An insistent demand has been made by various interests in the lower valley for the opening of hearings on the Robinson amendments. Formal resolutions urged the committee to begin these hearings not later than Jan. 15. Chairman Reid has decided, however, that nothing will be gained by opening hearings before the recommendations of the Chief of Engineers have been submitted.

Louisiana Favors Reservoir System

Adherents are being found in the Louisiana Congressional delegation to the reservoir system of flood control, sponsored by Harry Jacobs, the state's chief engineer. The biggest single difficulty lying in the way of the Jacobs plan, however, appears to be the belief that its adoption would cause a long delay.

During his recent visit to Washington to take part in the Rivers and Harbors Congress Mr. Jacobs revealed his ideas as to how the Jadwin plan should be modified. He would have Congress authorize the construction of the eleven reservoirs studied by the Mississippi Reservoir Board in 1927. With these storage basins in prospect, he would eliminate the Boeuf floodway and narrow the Atchafalaya, providing continuous levees and doing away with openings for back water. He would have Congress provide payment for all land flooded or made subject to flooding, a total area which would not exceed 1,810,000 acres, according to Mr. Jacobs' estimate. He also estimates that the total under the Jadwin plan would be 4,242,000 acres, nearly all of which is in Louisiana. Total cost of the Jacobs-Jadwin plan was figured by the Louisiana engineer as $715,000,000. Mr. Jacobs contended that if payment is made for lands on a basis of two and a half times the assessed valuation, the Jadwin plan unrevised will cost far more than $715,000,000.

The outstanding feature of the Jacobs plan is the creation of a very large artificial lake near Little Rock, Ark., where a dam would be constructed with a height of 180 ft. above foundation. This one reservoir would hold 25,300,000 acre-ft. of water. Of the ten other reservoirs included in the tentative line-up of the Arkansas and White rivers, six would lie in northern Arkansas and four in Missouri. The eleven reservoirs would have a combined storage capacity of 38,000,000 acre-ft.

Increasing Appropriations for Rivers and Harbors

In order to speed up the work of the army engineers, efforts are being made to induce the House appropriations committee to increase the sum made available to the War Department each year for civil engineering operations. At present, the Corps of Engineers receives about $50,000,000 a year. Two-fifths of this amount is required to be used for maintenance on the various projects, leaving only $30,000,000 for new work.

As the projects authorized but not yet undertaken total $200,000,000, it is evident that with a yearly fund of $30,000,000 the engineers must plan their operations in seven-year periods to complete all the work. Moreover, it is virtually certain that during this session the rivers and harbors committee will authorize new project bringing the total amount involved in the new work up to $350,000,000.

When the new projects are approved it will mean that the army engineers will have to increase their working period from seven to ten years unless larger appropriations are allowed. It has been suggested that the funds be increased to $75,000,000 a year. Another proposal that has been made is that as large an amount of the unfinished work as is practicable be provided for each year in a deficiency bill.

State Aid for Mapping

In the effort to secure the completion of the topographic map of the United States in eighteen years, the federal government is attempting to induce the states to increase their appropriations for that purpose. The amount the federal government can expend under the present policy is limited by the amount of money the states are willing to devote to that purpose. During the fiscal year beginning next July the various states have provided appropriations aggregating $534,000. The U. S. Geological Survey has at its disposal for the next fiscal year a total of $811,000 which could be used to match state appropriations. Since the states are not ready to take up the entire amount, the remainder will be available for mapping work in the national forests or other federal projects.

An Engineer for the I.C.C.?

Appointment of an engineer to the Interstate Commerce Commission appears to be more likely now than at any time in the past. With the resignation of Johnston B. Campbell, Republican, of Spokane, President Hoover has an opportunity to make an appointment to membership on that body without having to give first consideration to political exigencies that ordinarily are so pressing. On that score the only qualifications appear to be that the man shall be a Republican and hail from the intermountain states.

The names of several prominent engineers have been presented to Mr. Hoover for consideration. Foremost among them are George Malone, state engineer of Nevada; Lester Ready, formerly chief engineer of the California Railroad Commission; and Governor Emerson, of Wyoming. It is believed that the appointment of any one of these men to membership on the Interstate Commerce Commission would be very gratifying to the engineering organizations. The appointment of Mr. Malone might prove to be good strategy, as he is generally credited as being the brains behind the opposition to the Boulder dam project, and this circumstance may have weight with the President in considering his nomination. Mr. Ready is a consulting engineer with wide experience in the public utility field. Governor Emerson's qualifications are political rather than technical, but he is also favorably regarded by the engineers.

Water Conference Called

Action by the Secretary of the Interior in calling a conference Jan. 20 of the governors of the states in the lower Colorado River basin was taken, it is believed, as an eleventh-hour effort to dissuade Arizona from filing its suit. The understanding was that the suit would have been filed by this time had it not been for that move of Secretary Wilbur. It is assumed that Arizona was willing to await the outcome of another conference, even if the prospects of its being successful are remote. If Arizona is not satisfied at that conference—few expect anything to come from it—it is assumed that suit will be filed at once.

Regardless of the outcome of the conference at Phoenix, Secretary Wilbur has announced his intention of signing contracts to cover the power to be developed at the Boulder dam. This will enable Congress to proceed with the appropriation of the money for construction work.

Personal Notes

NORMAN M. STINEMAN, for some years structural engineer of the Portland Cement Association in charge of building code work and related activities, has been appointed editor of the monthly magazine *Concrete*, published in Chicago. Mr. Stineman succeeds O. A. Steller, who has moved to Los Angeles as advertising manager for McEverlast, Inc.

MURRAY C., GEORGE C., HARRY A. and WILLIAM A. STREET have purchased the interest of Robert Bird in the Bird & Street Bros. Construction Company, Syracuse, N. Y., and will do general contracting as the Street Bros. Construction Company.

T. TANAKA, civil engineer, of Tokyo, Japan, arrived in Denver, Colo., Dec. 23 on a tour of inspection of concrete road work leading to the mountains and between cities along mountain roads.

JOHN S. DENNIS, chief commissioner of the department of immigration and colonization of the Canadian Pacific Railway, has resigned after 29 years service. He has been succeeded by J. N. K. MACALISTER.

BENJAMIN E. TILTON, vice-president and general manager of the New York State Railways since 1918, has been elected president to succeed James F. Hamilton, resigned. Mr. Tilton was graduated from Cornell in 1897 and has held positions with the U. S. Coast and Geodetic Survey, the Pennsylvania Railroad and the Cleveland street railway.

W. W. GREGORY, assistant county highway engineer of Guilford County, N. C., has resigned to become district manager in charge of the New York office of Froehling-Robertson, Inc., testing engineers, of Richmond, Va. He has been connected with the engineering department of Guilford County for about eight years.

CLAUDIUS E. BENNETT, assistant professor of electrical engineering at the University of Florida, has been appointed city manager of Fort Pierce, Fla., to succeed T. H. Banes, resigned.

ROBERT ISHAM RANDOLPH, consulting engineer of the Randolph-Perkins Company, has been nominated (tantamount to election) to the presidency of the Chicago Association of Commerce, one of the largest organizations (7,000) of its kind in the country. For years bankers have held the position. For some time Mr. Randolph has been a member of the executive committee of the association.

ALBERT G. BEAR has resigned his position with J. W. Billingsley, New Orleans consulting engineer, to assume new duties as associate supervising architect of the United States. Mr. Bear left New Orleans on Jan. 4 for Washington. He severed a connection of twelve years.

C. E. PLUMMER has been made superintendent of power distribution and L. H. PARKER is now assistant engineer of the Turlock (Calif.) Irrigation District, following the resignation of R. W. Shoemaker, for several years electrical superintendent for the district, who has accepted a position in Rio de Janeiro with Electric Bond & Share Company interests.

ALANSON D. MOREHOUSE has been appointed to the distribution division of the Bureau of the Census as chief of the construction section for the conduct of the first general census to be made of the contractors' group of the construction industry. For several years he has been associated with the division of building and housing of the Bureau of Standards as mechanical engineer.

E. W. FASSETT, who has been city manager of El Reno, Okla., for the past three years, has accepted the post of city manager of Ironton, Ohio.

P. C. PAINTER has resigned as city manager of Greensboro, N. C. His successor has not been named, but there are 30 applications for the post.

Society Calendar

AMERICAN CONCRETE INSTITUTE, Detroit; annual convention, New Orleans, La., Feb. 11-13.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual meeting, Chicago, Ill., March 11-13.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington; annual convention, Atlantic City, N. J., Jan. 11-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; annual meeting, New York City, Jan. 15-17.

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago; annual meeting, Seattle, Wash., Jan. 28-30.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington; annual convention, New Orleans, La., Jan. 20-22.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, Trenton; annual convention, Syracuse, N. Y., Feb. 19-21.

ENGINEERING INSTITUTE OF CANADA, Montreal; annual convention, Ottawa, Ont., Feb. 12-14.

NATIONAL CRUSHED STONE ASSOCIATION, Washington; annual convention, Cincinnati, Ohio, Jan. 20-23.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington; annual meeting, Memphis, Tenn., Jan. 28-30.

AMERICAN CONSTRUCTION COUNCIL has elected new officers as follows: honorary president, Franklin D. Roosevelt, Governor of New York; honorary vice-president, Harry A. Wheeler, vice-chairman of the First National Bank of Chicago; president, E. M. Craig, Chicago; vice-president, Sidney P. Heckert, president of the National Fire Proofing Company, Pittsburgh.

ILLINOIS SOCIETY OF ENGINEERS will hold its 45th annual convention Jan. 22-24 at East St. Louis. Seven technical sections will meet. W. D. Gerber, Urbana, is acting secretary.

NEW YORK STATE SEWAGE WORKS ASSOCIATION will meet Jan. 18 in New York City.

SOUTH DAKOTA SOCIETY OF ENGINEERS AND ARCHITECTS and SOUTH DAKOTA CONTRACTORS' ASSOCIATION will hold a joint annual convention Jan. 15-16 at Rapid City.

TEXAS WATER WORKS SHORT SCHOOL for water and sewer plant operators will be held Jan. 27-30 at Abilene, Tex.

UNIVERSITY OF COLORADO, Boulder, will hold its annual Highway Engineering Conference Jan. 16 and 17.

Obituary

WILLIAM J. DUNZWEILER, founder of the Dunzweiler Construction Company, one of the best known contracting concerns in eastern Ohio, died in Zanesville, Ohio, Dec. 29 from a heart attack. He was 69 years old.

JOHN SILVER, for the past several years assistant engineer for Columbia, Mo., and at one time city engineer, died in a hospital at Columbia on Jan. 2 from a fractured skull. The manner in which he was injured has not been ascertained, as he did not recover consciousness after being taken to the hospital.

ROBERT A. MARR, former head of engineering departments at Virginia Military Institute and Virginia Polytechnic Institute, died at his home in Norfolk, Va., on Jan. 2. He was 73 years old. For a number of years he was with the U. S. Coast and Geodetic Survey.

JOHN W. EUBANKS, who 50 years ago surveyed the route of the Texas & Pacific Railroad through west Texas, died at his farm near El Paso, on Dec. 25. He was 75 years old. For fourteen years he was county surveyor of El Paso County.

DANIEL FREDERICK DOW, chief engineer of the Pigeon River (South Carolina) hydro-electric development, died of pneumonia at a construction camp near Asheville, N. C., Dec. 29. Mr. Dow made the preliminary surveys for the big power development on Pigeon River five years ago, and remained on the project until he was striken with pneumonia several weeks ago. He was 47 years old.

WILLIAM J. PARRISH, widely known in the South as a railroad builder, died on Dec. 25 at his home in Millport, Ala., after a long illness. Mr. Parrish, who was 89 years old, helped build the old Georgia & Pacific Railroad in 1880 and was in charge of operation of the road until it was completed to Birmingham. When the Southern Railway purchased the line, he was made superintendent of transportation of the division between Birmingham and Columbus, and held that position for many years.

ALBERT BANKS HILL, city engineer of New Haven, Conn., from 1883 to 1892, died in that city on Jan. 2. He was 82 years old and one of the oldest graduates of Yale University. He designed the New Haven city sewerage system, the bridge over the Norwalk River and most of the public works construction of the city of New Haven. He laid out sewerage systems for Danbury and Shelton, the disposal works for Litchfield and Greenwich, and electric railways in Norwalk, New Haven, Bridgeport, Fairfield, Derby, and from Palmer to Springfield, Mass. He was a former director of the American Society of Civil Engineers and president of the Connecticut Society of Civil Engineers.

Construction Equipment and Materials

Common Brick Industry Will Hold Trade Conference

Selection of Feb. 3 as the date and Memphis, Tenn., as the place for the trade practice conference of the common brick industry has been announced by the Federal Trade Commission, Washington, D. C. It is expected that manufacturers representing 75 per cent of the total production of the industry will attend to discuss present trade practices with a view to adopting rules for better regulation in the industry.

Plan Retail Distribution of Treated Lumber in Ohio

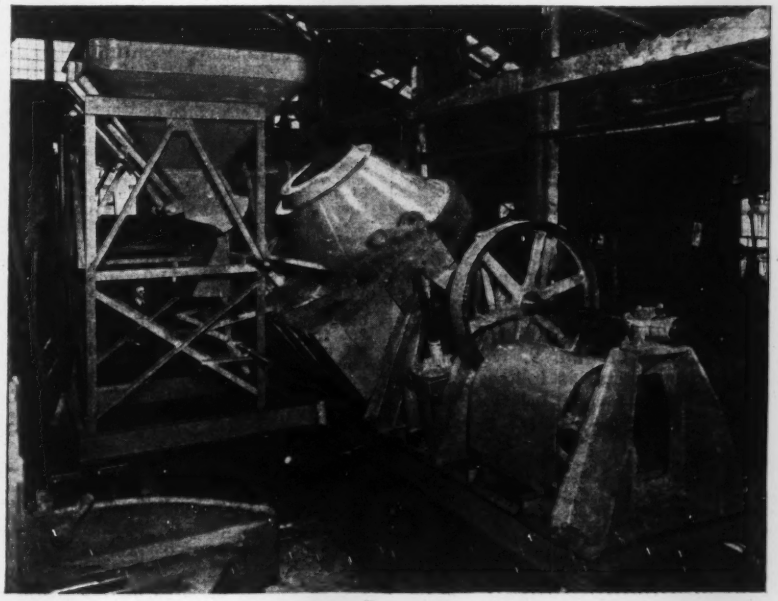
Distribution of treated lumber to small consumers throughout the State of Ohio has been inaugurated under the direction of a special sub-committee of the national committee on wood utilization, U. S. Department of Commerce. The material will be distributed through members of the Ohio Retail Lumber Dealers Association. Other organizations co-operating in the plan include the National Lumber Manufacturers Association, the American Wood Preservers Association and the National Grange. To provide non-technical consumers with information on preserved wood and its advantages, booklets are being prepared which will be distributed throughout the state to lumber users. The movement is being pushed in the belief that the ready availability of treated lumber at retail yards will result in the saving of millions of dollars now lost annually in the state as the result of timber deterioration and decay.

New Developments

Large Concrete Mixers Built for Owyhee Dam

Two 4-cu.yd. concrete mixers have been shipped from the machine works of Norris K. Davis, San Francisco, Calif., to the General Construction Company, contractor for the Owyhee dam, Oregon, now under construction for the U. S. Reclamation Service. These giant mixers have capacities of 112 cu.ft. of mixed concrete and will be used for batches of 4 cu.yd. each. The drums have a maximum inside diameter of 110 in. and are 13 ft. long from inlet to discharge spout. A cast-iron ring 4½ in. thick and 18 in. wide weighing 5 tons carries the weight of each drum and is toothed to permit drive through bevel gears from a 100-hp. 440-volt electric motor. The motor speed is 575 r.p.m. and the drum speed is 10 r.p.m.

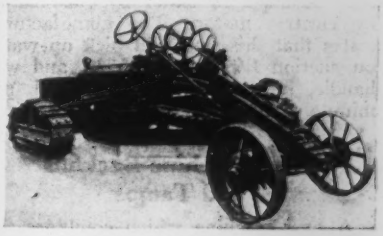
Except where the shells are riveted to the center rings, they are of welded construction and consist of ⅜-in. shells, a ⅜-in. thickness of liner and a layer of Davis process hard steel surfacing applied by the electric welding process over the entire inside surface, including vanes. This surfacing covers 348 sq.ft. in each drum and is expected to last throughout the entire job without relining. All bearings are of the self-aligning roller type. Tilting for discharge is done by 19-in. air cylinders, arranged with cushion pockets at either end. When empty, the tilting part of the machine is balanced at all times so that the tilting mechanism is required to handle only the charge of concrete. The maximum amount of tilt used is 66 deg. Inlet and outlet openings are of 34-in. diameter. Each unit as shipped, including drum, motor drive and frame, weighs 55,000 lb. The charging hopper, shown in the accompanying illustration, weighs an additional 11,000 lb.



4-CU.-YD. TILTING MIXER WITH CHARGING HOPPER

Improvements Made on Standard Motor Grader

New features of the model E Warco power grader manufactured by the W. A. Riddell Company, Bucyrus, Ohio, include a new circle and the strengthening of parts subject to unusual stress and wear in addition to the automotive-type steering gear, inclosed lifting mechanism and interchangeable rubber-tired wheels and crawlers, featured in previous models. The new circle, of special design, consists of a one-piece steel casting so constructed that the blade hanger is securely attached to it and the whole firmly mounted in the circle drawbar.

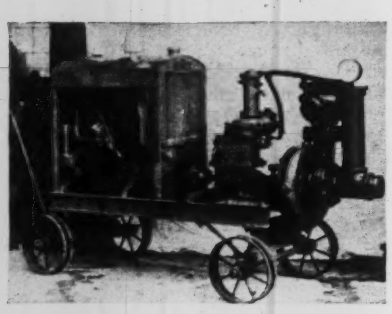


IMPROVED POWER GRADER WITH CRAWLER TREAD

Auxiliary Diaphragm Pump Used to Prime Centrifugal Unit

Automatic priming is provided for in a new centrifugal pump developed by A. S. Marlow, Ridgewood, N. J., by means of a separate diaphragm pump connected with the suction lead of the centrifugal unit by an automatic control valve. When the pump is first started the diaphragm pump exhausts the air from the suction line and draws water to the centrifugal pump, after which it is automatically cut out by the control valve, resulting in a saving of power and minimum wear on the diaphragm. The control valve is adjustable so that it can be regulated to cut out the priming pump at different points to suit varying conditions. Creation of the vacuum is aided by the use of a ball check valve on the discharge line of the main pump.

The auxiliary pump is designed along the principles of the Marlo Mud Hog diaphragm force pump, with ball valves and a small diaphragm. As water, sand and grit will pass through this unit

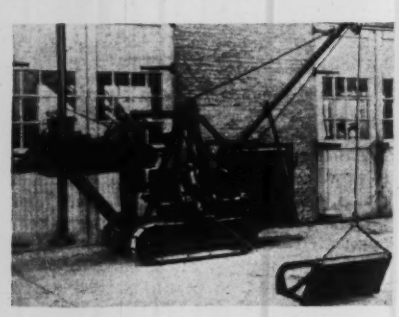


SELF-PRIMING CENTRIFUGAL PUMP WITH GASOLINE POWER

without damage, there is no necessity for traps or other devices to prevent water from reaching the priming pump. Use of a diaphragm instead of a piston permits high efficiency of the vacuum pump, and inasmuch as this pump operates for only a short period, the diaphragm is expected to be unusually long lived. Power for the pump unit may be supplied either by gasoline or by electric motor. The manufacturer states that this unit will pick up water on suction lifts up to 25 ft., and will handle, in the 4-in. size, 500 gal. per minute against the total head of 35 ft.

New Machine Backfills and Tamps

A new machine which combines the operations of tamping and backfilling has been developed by the Cleveland Trencher Company, Cleveland, Ohio. It is mounted on crawler traction for ease in operation over rough ground. The tamping mechanism, which will work either at the center or side of the machine, consists of a 150-lb. steel tamping head which can be dropped 45 times per minute from a height of 26 in. Gear shift speed changes provide instant

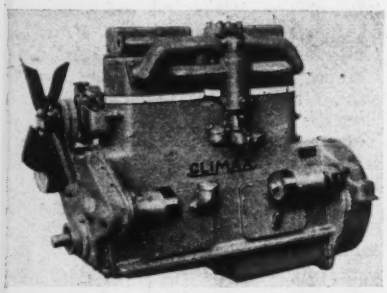


SELF-CONTAINED UNIT FOR BACKFILLING AND TAMPING

means of determining the number of blows struck per given distance, according to the requirements of the soil. Backfilling and tamping speeds of 3½, 7 and 11½ ft. per minute are available, and the unit has a road speed of 5 miles per hour. The backfiller, of the conventional type, operates with a telescopic boom with a length which can be varied from 14 ft. 2 in. to 20 ft. 2 in. The entire unit is self-contained and is powered by a four-cylinder Hercules model OX gasoline motor.

Industrial Motors Available in Four Sizes

Particular attention has been paid to the combustion system in the design of the Blue Streak series of heavy-duty industrial engines producted by the Climax Engineering Company, Clinton, Iowa, in order to secure maximum power output and economy with low grade fuels. Since the first of these motors was described in *Engineering News-Record*, Nov. 29, 1928, p. 824, three additional models have been added, so that the complete line now includes one six-cylinder engine, with a bore of 6 in. and a stroke of 7 in., developing 130-150 hp., and three four-cylinder motors with maximum outputs of 100, 85 and 72 hp. respectively, and



FOUR-CYLINDER MOTOR DEVELOPING 72 HP.

cylinder dimensions 6x7, 5¾x6½ and 5¼x6½ in. All of these models operate at a maximum speed of 1,000 r.p.m. In design they are similar, having specially designed combustion chambers with overhead valves, very large and efficient cooling systems and combustion control to give high efficiency by means of valve design, spark plug location and flame travel.

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Jan. 1, 1930		**208.96**	**December, 1929**		**166**
Dec. 1,	1929	209.46	November,	1929	245
Jan. 1,	1929	209.40	December,	1928	244
Average,	1929	207.02	Average,	1929	317
Average,	1928	206.78	Average,	1928	287
1913.....		100.00	1913.....		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Jan. 9, with some comparisons, total as follows:

(In Thousands of Dollars)

	Jan. 9, 1930	Jan. 2, 1930	Jan. 10, 1929
Buildings:			
Industrial.....	$1,794	$2,982	$12,898
Commercial....	16,749	17,888	29,001
Streets and roads.	4,516	7,726	7,806
Other eng. constr.	19,256	11,421	23,934
Total.....	$42,315	$40,017	$73,639
Total, all classes, Jan. 1 to Jan. 9:			
1930.....			$82 332
1929.....			117,873

Business Notes

SIDNEY F. HECKERT, president of the National Fire Proofing Company, Pittsburgh, Pa., has been elected president of the Eastern Hollow Building Tile Manufacturers' Association, New York City.

ERWIN E. DREESE, chief engineer of the Lincoln Electric Company, Cleveland, Ohio, has been appointed professor of electrical engineering at Ohio State University. Mr. Dreese is a graduate of the University of Michigan, where he received his electrical engineering degree in 1920.

YEOMANS BROTHERS COMPANY, Chicago, Ill., has elected D. W. Burgoon vice-president and general manager.

SULLIVAN MACHINERY COMPANY, Chicago, Ill., has established a branch office at Johannesburg, South Africa, in charge of Charles C. Smith.

STUEBING COWAN COMPANY, Cincinnati, Ohio, a division of the Yale & Towne Manufacturing Company, Stamford, Conn., has completed a new plant in Cincinnati.

PORCELAIN PRODUCTS, INC., Findlay, Ohio, manufacturer of electrical porcelain insulators, is starting the production of floor and wall tile.

AMERICAN CREOSOTE WORKS has begun construction of a new plant at Jackson, Tenn., which will have a capacity of about 2,000,000 b.ft. of lumber per month.

NAYLOR PIPE COMPANY has appointed Alec S. Field assistant director of sales. Mr. Field was formerly with the Shell Petroleum Corporation and the Standard Oil Company of Louisiana.

PERMUTIT COMPANY, New York City, has elected H. Kriegsheim, president of the company for the past seven years, chairman of the board. W. Spencer Robertson, formerly secretary of the American Locomotive Company, has been appointed president.

UNITED STATES PIPE & FOUNDRY COMPANY, Burlington, N. J., announces that J. D. Capron, for many years its publicity manager, has resigned to become general manager of the Glamorgan Pipe & Foundry Company, Lynchburg, Va. He will be succeeded as publicity manager by S. E. Linderman.

PITTSBURGH BRIDGE & IRON WORKS, Pittsburgh, Pa., has appointed A. H. Doering sales manager. Mr. Doering for the past year has represented the company in Cleveland, and was previously chief engineer of the Forest City Structural Steel Company, Cleveland, Ohio, and of the Riverside Bridge Company of Wheeling, W. Va.

TAYLOR-WHARTON IRON & STEEL AND ASSOCIATED COMPANIES have announced the following changes in personnel: A. F. Marwick, formerly general sales manager for the Pettibone-Mulliken Company, has joined the Chicago district sales staff of the Taylor-Wharton Iron & Steel Company and William Wharton, Jr., & Company, Inc.; G. V. Wood, recently located at the Highbridge plant of the Taylor-Wharton Iron & Steel Company, is now Western sales manager for the associated companies, with headquarters in San Francisco; J. R. Van Rensselaer, formerly sales representative with the company's San Francisco distributor, is now at the New York office of William Wharton, Jr., & Company, Inc.

TRACKSON COMPANY, Milwaukee, Wis., has announcesd plans for the erection of a new factory on a recently acquired 21-acre site. The entire Trackson organization will be housed in the new factory, which will replace several plants now operated in the city.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., has started work on an eleven-story central engineering laboratory at its East Pittsburgh plant, which will be 80 ft. wide and 225 ft. long. Adjacent to this will be built an addition to the present direct-current power laboratory. The new facilities will eventually replace numerous smaller laboratories and experimental test sections now scattered throughout the plant.

NATIONAL EQUIPMENT CORPORATION, Milwaukee, Wis., a consolidation of the Koehring and T. L. Smith companies, of Milwaukee, the Insley Manufacturing Company, of Indianapolis, the Parsons Company, of Newton, Iowa, and the Kwik-Mix Concrete Mixer Company of Port Washington, Wis., became an operating company Jan. 1. Sales, service, advertising and accounting departments have been centralized. R. E. Brooks, for a number of years engaged in the equipment business in New York, was recently elected vice-president and will be in charge of sales.